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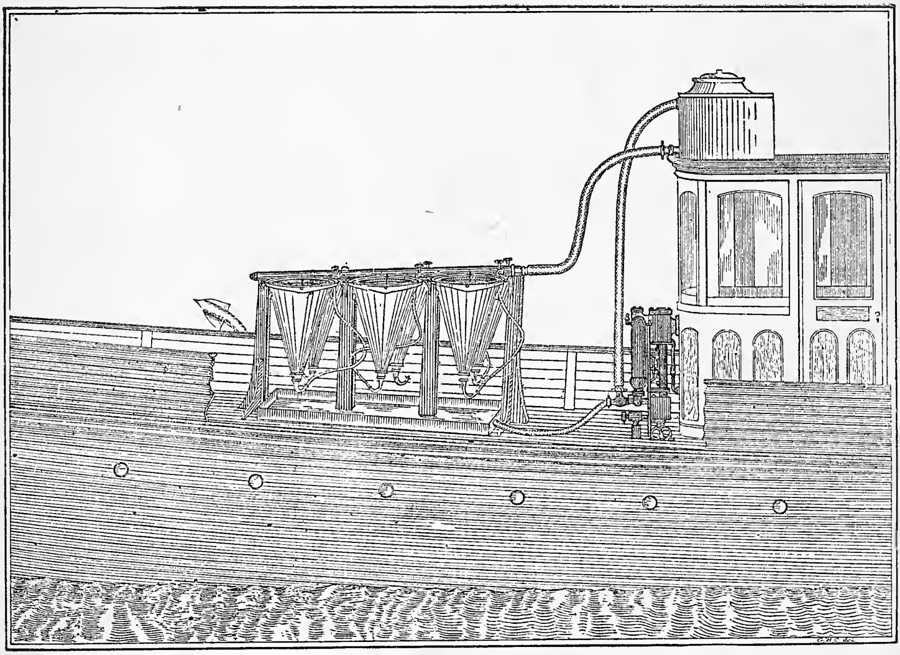


Shad Hatching Equipment on Bow of Steamer Lookout.

REPORT

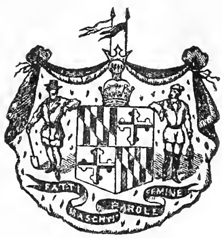
OF THE

COMMISSIONERS OF FISHERIES

OF

MARYLAND.

JANUARY, 1880.



ANNAPOLIS:
MARYLAND REPUBLICAN, PRINT.
1880.

3 Mollusks

REPORT.

To his Excellency, JOHN LEE CARROLL,
Governor of Maryland:

In each successive Report of the labors of the Commission on Fisheries, in addition to a detailed statement of the actual work performed, we have given a minute description of the apparatus used in artificially increasing the supply of food fishes, and have traced, step by step, the advance that has been made in perfecting it.

We have also stated the results of investigations as to the development of the different varieties of food-fishes, and the varying degrees of success attending our efforts to propagate artificially those species which had not hitherto been the subjects of such experiment.

Although we cannot now report any appreciable improvement during the past year in the apparatus used, we are able to state that most satisfactory results have been realized from the employment of the methods already described. Heretofore the results obtained in other localities have formed the only basis on which we could promise an increase in the supply of our native food-fishes; but we are now enabled, from convincing statistics, to show the absolute increase in our own waters of shad—the fish which has been the object of our special care.

The sudden and marked increase in the supply of this valuable fish in the Chesapeake Bay is a result most flattering to the labors of the Commission. In the Report made to your Excellency in January, 1878, on page 6, we chronicled the noticeable increase in the supply of shad as reported by the fishermen in the neighborhood of Annapolis. As stated at that time, the return of adult shad could be expected during their third year, and the increase just mentioned was doubtless the result of our hatching operations in the spring of 1875.

In the year 1876 we transferred the base of our operations to the "Head of the Bay," and during that season nearly two million (2,000,000) of young shad were deposited in the Susquehanna and the Chesapeake Bay, near its mouth. The return of many of the males of these fish was to be expected in the spring of 1878, and of a much larger number, accompanied by adult females, during the following season.

As we have already stated in several previous Reports, the return of shad from the salt water to their native rivers is for the sole purpose of reproduction, and therefore only the adult shad make these annual migrations from the sea. Hence we could not expect, during 1877, any increase from the two millions (2,000,000) of young shad deposited, as above mentioned, in the Susquehanna River and Chesapeake Bay in 1876.

Through the kindness of a firm which has shipped the largest portion of the catch of the gill-nets in the neighborhood of Havre de Grace for several years, we have obtained the following figures. (Although the books of this firm do not show the actual catch of shad at the Head of the Bay, they indicate approximately the relative amount taken each year.)

For year 1870	48,527
" 1871	30,101
" 1872	62,451
" 1873	40,295
" 1874	50,246
" 1875	40,150
" 1876	35,539
" 1877	47,150
" 1878	50,310
" 1879	75,525

We have the record of the shipment of 45,000 shad in addition to the above in the season of 1879 by another merchant.

The decided increase in the catch of shad by the gill-nets may not be entirely the result of the deposit of the large number of young shad by the Commission, yet it is, doubtless, due in a great degree to that measure. It may be objected that the increase in the supply of shad in 1878 was caused by the state of the weather or water, or by the prevalence of

the wind in a certain direction; but, upon any one of these hypotheses, the same favorable conditions would cause a corresponding increase in the number of the other fish (the herring, for example), that usually accompany the shad in their annual migrations. So far, however, from this being the case, the herring fisheries last year were unremunerative, there being a great scarcity of that species. It will be remembered that the Commission has as yet taken no steps towards the artificial propagation of herring in Maryland waters, although we have carefully investigated their habits with a view to future operations.

In order to ascertain whether there had been the same marked increase in the catch of the haul-seines which are operated on the Susquehanna and Head of the Bay we have, through the courtesy of the owners of the large fisheries, examined their books, and have been able to ascertain, with tolerable accuracy, the amount of shad taken since 1872 by this mode of fishing. The books showing the catch of nineteen seines in this portion of the State give an aggregate yield of shad

In 1872	156,212
" 1873	133,050
" 1874	162,421
" 1875	252,829
" 1876	136,633
" 1877	152,765
" 1878	134,861
" 1879	188,870

The decrease of shad up to 1877 is, perhaps, much more marked than is shown in this table, as from several of the fisheries we could not obtain accurate records further back than that year, whereas the figures for 1877, '78 and '79 show the entire catch of the nineteen seines during those years. It will be noticed that in 1879 54,009 more shad were taken than during the previous season, and 36,005 more than the total catch of 1877.

As during the season of 1879 we could expect the return of the shad to the Potomac, Patuxent and other rivers where our operations were also conducted on a considerable scale,

we would look for a proportionate increase in the number of fish brought to and consumed in the city of Washington. Unfortunately for us, Washington is the only place where an accurate record of the fish product is kept. The Health Commissioner of that city is required to inspect all marine products and report the number examined. We have taken from his reports the numbers inspected during the same period, and there the increase is as noticeable as at the Head of the Bay.

In	1872	he inspected	917,221	shad.
"	1873	"	852,900	"
"	1874	"	628,637	"
"	1875	"	464,215	"
"	1876	"	319,079	"
"	1877	"	131,199	"
"	1878	"	121,785	"
"	1879	"	328,435	"

We have additional testimony tending to prove that the increase of the supply of shad is the result of artificial propagation. By reference to our report of January, 1877, which recorded the shad hatching operations at the Head of the Bay, it will be noticed that a large number of fish were deposited in Swan Creek. During that season we were compelled to seek a locality in which there was a current sufficiently strong to afford to the eggs the necessary agitation and change of water. We, therefore, established one of the hatching stations on the creek just mentioned, as it offered the required conditions, and to that point transferred nightly the eggs taken on the flats. As soon as the fish were hatched they were deposited in the immediate vicinity of the hatching station. During last season, after an almost total absence of many years, adult shad appeared in this creek in such numbers as to attract several fishermen, whose labors were here amply rewarded.

The fishermen who operated there last season report a preponderance of small male or *buck shad.*

We have not, hitherto, felt justified in promising to do more by artificial propagation than simply to arrest the alarming decrease in the yield of the fisheries of the State. But from the results already obtained we are now confident of our

ability to render our waters as productive of the most useful varieties of food-fishes as they have ever been.

That we are daily becoming better fitted to realize this expectation is evidenced by the marked increase in the number of fish produced at the headquarters of shad hatching operations in Maryland.

A reference to the tables giving the result of our efforts will show that we deposited in these waters during the spring of 1876, 2,724,000 young shad. Next season this number was increased to 2,134,800; in 1878 to 8,285,000; and in 1879 to 7,757,000.

Since the inauguration by us of the new system of hatching shad—which is independent of the necessity for a strong current, to obtain which we were often compelled to visit remote parts of the State—the yield has been steadily increasing, and now the means of hatching are such that the quantity produced is limited only by the number of trained experts available for collecting the eggs. In 1874, when the Fish Commission was organized in Maryland, there was not a single person in the State who had ever taken or artificially hatched shad eggs, but there are to-day many men trained by the Commission in the manipulation of shad and other fishes who are as expert as any in the country.

An account has already been given of the results of experiments by the Commission in the artificial propagation of smelt and herring, and we are now enabled to record our success in propagating, by similar means, another species, more important, perhaps, than any of the fishes that have hitherto been the object of the care of fish culturists. We refer to the rockfish (*roccus lineatus*).

Our previous reports have called attention to the importance of this species, which we consider second to none of those frequenting our waters. We have also reported our constant but futile search for its spawning grounds, and for a ripe female of this fish. We are now, however, happy to record our success, not only in the search for the ripe fish, but in the discovery of the spawning grounds; and we have been reason ably successful in the manipulation of the eggs.

There is no fish in our waters whose decrease has been more marked than that of the Rock, and none which occupies a more important place among the food-fishes. Though never seen in our markets in such numbers as the shad and herring, they are in season nearly the whole year, and to be procured almost daily in greater or less abundance in our principal fish depots. Thriving as well in the fresh waters of our rivers as in the salt water of the sea, or the brackish water of bays and inlets, they are found in almost all the tidal streams of the State. To a large number of people, therefore, an abundant supply of them is to a greater extent, perhaps, than of any other fish, an important desideratum.

On the organization of the Commission our first work was to investigate the waters of the State with a view to ascertain their capacities as well as their needs. In prosecuting these researches we were enabled to make a very large collection of specimens of the ichthyology of the State, and to discover the existence in our waters of many species that have never before been seen in them, and of others that were new even to the Atlantic coast.

In our report of January, 1876, we published a descriptive list of the fishes of the State, to which list additions were made in two subsequent reports. We discovered, last year, the presence of a number of fish not included in any of the lists referred to, as they were not before known to visit our waters.

After the investigations above mentioned, our labors were addressed to the task of supplying the deficiencies that were found to exist.

In order to obtain information on certain important points, Col. Hughlett, one of the Commissioners for the State of Maryland, addressed circulars containing the necessary questions to a large number of persons likely to be interested in the fisheries on the Eastern Shore. The answers, in full, to these questions received up to January 1st, 1880, are herewith transmitted, though we do not endorse the views contained in many of them.

Most of the information sought in these interrogatories will

be furnished by the Census Bureau in preparing statistics, &c., for 1880. If, however, the items obtained from this source are not satisfactory and complete for the State of Maryland, we will issue during the ensuing season another series of questions calculated, we trust, to elicit all necessary information.

The following are the questions, as above stated, by Col. Hughlett:

QUESTIONS.

1. Have you ever engaged in fishing for a livelihood, and if so, for how many years?

2. In what waters do you usually fish?

3. Have you ever studied the habits of fish?

4. When do shad spawn in your waters, and are they more abundant before or after the spawning period?

5. Do you keep an account of the number of fish you catch during the season, of the temperature of the water and of the range of the winds?

6. How does the shad-fishing of this season compare with that of last year, and of the past few years? Please state what you consider the cause of the increase or the decrease, as the case may be.

7. What kinds of fish do you catch in your river, and in what proportions? What fish do you consider best adapted to your waters?

8. Have you kept an account of the number or quantity of fish you have sold for several years past? If so, please state the proportions of rock, of shad, of herring, of taylors, of perch, and of any other fish, and the ruling price of each kind on the shore.

9. Have you ever caught a ripe female rock?

10. Which sex of the rock predominates, and in what ratio?

11. What are the size and weight of the largest you ever caught, and can you tell the average growth per year?

12. Do the sexes differ in respect to shape, size and rate of growth?

13. Do you consider the rock too destructive to other varieties of fish to justify its artificial propagation.

N. E. Nicols, *Easton, Maryland.*

1. Have fished at different periods for forty years. Have never fished for a livelihood.

2. In the Great Choptank River.

3. Have not. Have learned more from practical experience than in any other way.

4. Spawning commences in April, but greater part is done in May and early part of June. Shad are most abundant from middle of April to first of May in our waters.

5. Have kept account sometimes. Have not specially observed the temperature of the water, or the range of the winds.

6. I think there has been a gradual decrease for several years, caused by the wholesale and destructive manner of fishing in the lower Choptank by the use of set and fyke nets, catching up the female shad before they reach their spawning grounds.

7. Catch more shad, herring, rock and perch than any other kinds. Catch mostly shad and herring in the river named. Rock and perch are caught more or less throughout the season. I think the several species here named best adapted to the Choptank.

8. Have not kept account of number caught. Shad generally bring from *ten* to *fifteen* or *twenty* dollars per hundred, herring from seventy-five cents to one dollar on shore, and large rock say five cents per pound.

9. Have caught ripe female rock in latter part of April and first of May.

10. The *male* always predominates.

11. The largest about seventy or eighty pounds. Know nothing of their growth per year; wish I did.

12. The female rock is generally larger than the male, but they do not differ much in shape. Know nothing about the rate of growth.

13. I think not.

A. D. Sessions & Co., *Baltimore, Maryland.*

1. Have fished for twenty-two years and have been connected with the fishing business for forty-eight years.

2. Chesapeake Bay, Patapsco River, Sassafras River, Susquehanna River, Bush, Gunpowder, Back, Chester, Magothy, Wye, Severn, South and West Choptank and Patuxent Rivers and numerous creeks.

3. I have, but only in their season.

4. In the month of May, and they are more abundant before spawning than after.

5. I have never kept such account.

6. No conclusion can be arrived at yet, as it is too soon, in my opinion, to estimate the quantity.

7. The permanent fish in our waters are mud-shad, rock, perch (white and yellow), pike, sun-fish, sturgeon, mullets, chub, eels and cat-fish.

The transient fish are shad, herring, alewives, taylors, sheep-head, porgies, trout, spots, flounders and Spanish mackerel. The permanent fish are best adapted to our waters. Shad, herring, alewives, taylors and mackerel are caught in abundance during their season, but the other transient fish specified are taken in limited numbers. The supply of fish is being constantly exhausted.

8. I have not kept such account.

9. The female is generally the larger. Have never caught a ripe female rock.

10. Male predominates. Don't know, as I have never noticed.

11. Have caught rock weighing eighty-six pounds. I think a rock more than doubles its size every year.

12. They are about the same.

13. No.

G. W. Jones, *Baltimore City.*

1. Yes, for forty years.

2. In Chesapeake Bay.

3. I have studied the habits of fish.

4. From 24th to 28th of April and up to 10th of June.

5. Yes, the temperature of the water rises and falls, and the winds blow heavy and light.

6. There is an increase in the shad this year. The people

who haul the channel catch and boil them for the purpose of making oil.

7. Rock, white and yellow perch, shad, herring, pike, mullet, sun-fish, cat-fish, bream, shad, sturgeon, crocus, diamond-fish, sheepshead, taylors, horse-mackerel and black-fish. Occasionally we catch a salmon-trout, silver gar and drum. Rock and perch are the best adapted to our waters.

8. About fifteen hundred bunches of rock, averaging ten pounds per bunch, and about 1,190 bunches of perch and other fish. About twenty six years ago I caught 4,586 bunches of rock at one haul.

9. Yes.

10. Yes.

11. I have caught rock of ninety pounds weight. A rock will grow about three or four inches in length per year, and will increase in weight about one pound.

12. The female rock is the larger.

13. No.

J. P. Todd.

1. I have for thirty-five years.

2. Choptank river.

3. I think I have.

4. From the 10th to the 20th of May.

5. I think the boats average from 500 to 600.

6. I don't think there will be as many shad this season. I think the pound weirs are breaking up the fish in these waters. They catch the young fish as soon as they are born.

7. Shad, herring, rock, perch and cat-fish.

8. From 500 to 1,000 per annum. Shad, ten cents to twenty cents each; rock, three cents to five cents each; perch, from eighty cents to one dollar per hundred; herring, from seventy-five cents to one dollar per hundred.

9. I have caught ripe female rock.

10. I think the male rock is ripe any time in spring. A ripe female rock is not often caught.

11. I have caught rock weighing from one to sixty-five pounds.

12. I don't think I do.
13. No.

R. S. EMORY.

1. About twenty years.
2. In Chester River.
3. I have not.
4. In the month of May. They are most abundant about April 20th.
5. I do not.
6. Much less. Cannot state cause. Have known them to be as scarce in previous years and then rapidly increase.
7. I. Rock, perch, white and yellow; cat-fish, mud-shad, shad, herring, crocus, taylors and mackerel. II. White and yellow perch principally. III. White and yellow perch, rock, shad and herring.
8. I have not.
9. I have not.
10. I. The male largely predominates. II. It is.
11. I. From sixty to seventy pounds. II. I do not.
12. They differ in shape, the male being the longer.
13. It is not.

SOLOMON BRINSFIELD.

1. I have never followed fishing for a livelihood, but sometimes angle for family use or for sport.
2. In the waters of Broad Creek.
3. Have not. The taylors visit our waters for about six weeks every year during August and part of September. Rock are easily frightened and driven away by the haul-seine.
4. We have no shad. They do not spawn in our waters.
5. Do not keep any account. In fact, may say I catch none, as there are none to catch, thanks to the haul-seines and other traps and modes of destruction. The haul-seine is by far the greatest enemy with which the fish have to contend, and should be abandoned absolutely.
6. Know nothing about shad-fishing, as there are none of

that species in our waters. If there is a decrease (and such, I am informed, is the fact) it is due to the haul-seine.

7. We catch (or rather, did catch some years since) rock, perch, crocus and taylors in their season, and sometimes trout and a few other varieties. We catch now a few taylors, the haul-seine not having destroyed all of that species, as they are migratory and not permanent in Maryland waters. I consider the rock, when protected, the best adapted to our waters, as it is native to them, and decidedly the best and most profitable food-fish.

8. Do not sell fish, and am ignorant of the price of them, but know that the price rules higher each year as the fish become scarcer.

9. Have made no observations worthy of note, and would not know a ripe female.

10. If I judge rightly the *male* greatly predominates. Would not know a ripe one of either sex.

11. On these points am ignorant. During a part of last fall a large number of small rock, about a foot long, were in our waters. Some of them probably escaped the haul-seine, as I have seen a few caught this fall, and the average length was fifteen or sixteen inches, from which fact I judge they grow in length about three or four inches a year.

12. As before remarked, the female of the same length is much broader, stouter and heavier than the male. Do not know about rate of growth.

13. Not by any means. Think there is no doubt that the rock should be propagated in every possible way. They are certainly, in my opinion, the most valuable food-fish in our waters; but it is not only useless—it is simply *absurd*—to try to propagate them without protection. If the haul-seine is not speedily abolished the rock will, in a very short time, become extinct in our waters. There is no escape if the haul-seine is allowed to sweep our coves, creeks, rivers, &c., indiscriminately. They feed to some extent on young fish, such as minnows, young alewives, &c., but I do not think them as destructive to young fish as the taylors are.

J. H. S. HUBBARD.

1. Have been engaged in fishing and dealing in fish for about twenty-five years.

2. In the Great Choptank River.

3. Have closely observed the habits of fish for many years.

4. Shad begin to spawn about the 25th of April and continue until the 1st of June. They are rapidly diminishing.

5. I keep an account of the catch, the temperature of the water and the range of the winds. The temperature of the water is from 30° to 50°. The best catch is made when the water is from 35° to 45° and the wind south, southwest, west and northwest. Fishing is poor in these waters when wind is from east or northeast.

6. Shad are diminishing at the rate of one-tenth per year. We attribute the decrease to the very effectual blockade of the lower part of the Choptank River by weir or stake nets, which destroy many fish and turn many back that would come up but for these obstructions.

7. We catch shad, herring, rock, perch, pike and cat-fish, of which three-tenths are shad, one-tenth herring, and six-tenths rock, &c. The white cat-fish is a valuable fish and ought to be propagated, as like all other fish in our waters it is rapidly diminishing.

8. Have kept an account of the fish sold since 1873. The catch has diminished one-tenth per year up to the spring of 1879. The herring are almost exterminated. Of the number caught three-tenths were shad, one-tenth herring and six-tenth were rock, perch, pike, cat-fish and other fish. I would call your attention to the importance of the earliest possible preparation for the propagation of herring. Twenty years ago the Eastern Shore rivers furnished enough of this fish to supply all that section of country, as well as Delaware, with salt food-fish, whereas in the spring of 1879 many people living along the Choptank could not get a fresh mess. The people of the Eastern Shore depend much on a supply of small bone bacon.

9. I have closely observed rock-fish. Have obtained ripe female rock on but five occasions.

10. Have never seen a ripe female rock weighing less than fifteen or twenty pounds, and but five under twenty pounds. They were all small rock. The roe has the appearance of smelt. We catch at least nine male rock where we catch one female.

11. The largest rock I have ever caught was five feet one inch long and weighed 92½ pounds, and was in a spawning condition when caught. The increase in weight for the first year is from 2½ to 3 pounds, the second year, 4 to 6 pounds, third year, 8 to 12 pounds, fourth year, 12 to 20 pounds, at which age they mature for propagation.

12. All small rock have the same appearance until they attain the weight of 16 or 20 pounds; then nine-tenths of the catch of rock are females. How do you account for that?

13. I don't think the rock-fish is destructive. They are river scavengers, and in cold weather move in immense schools, taking up useless little pests, such as minnows, mill-roach, sun-fish and other small fry that destroy the food of more delicate fish. In summer they scatter all over the river and feed on the accumulated pests. At the approach of frost they form schools and move to and fro in the water.

N. B. I would call your attention to the protection of the alewife. I think the law should prohibit the catching of them at all times when it could be avoided. They are fish that prey on the fish-leach, flea and fish-lice that inhabit the waters in large numbers, much to the annoyance of the fish. Their young are eaten by rock in large numbers.

Littleton Smith, *of Wicomico County.*

1. I have for twenty-five years.
2. In the Wicomico River.
3. I have.
4. They are more abundant about the last of April and the first of May than at any other time.
5. I have not kept an account of the number of fish caught or temperature of the water.
6. The catch of shad was larger this year than for several

years previous. I attribute the increase to the efforts of the Fish Commission.

7. Shad, herring, rock, perch, pike, mullet, sun-fish, roach and cat-fish. Shad, herring, rock and perch are the principal fish caught in our river, and I think that they, with the black-bass, are best adapted to our waters.

8. I have kept no account of the number of fish sold for several years, but think about one-eighth rock, three-eighths shad and the balance herring and perch.

9. I have—I have.

10. The male or stag rock is the more abundant. Very seldom caught a ripe female.

11. Seventy-five pounds. I know nothing of their growth.

12. They do.

13. I think not.

ANDREW AIREY, *Dorchester County.*

1. I have for forty years.

2. Choptank River.

3. I have.

4. From 20th of April to same time in May.

5. I do not.

6. Shad have been fewer for several years. I attribute decrease to stake ponds. There have been more rock for the past two years than for the fifteen years previous. I attribute increase to the Fish Commission.

7. Rock, perch, shad, herring and taylors mostly. Rock are best adapted to our waters.

8. Mostly rock and perch. The prices vary according to the markets.

9. I have frequently seen ripe rock.

10. There are a great many more male rock.

11. Seventy-five pounds. Cannot tell growth, but they grow very fast.

12. The female is short and thick; the male is long and slender.

13. The rock is not destructive, and I deem it by all odds

the best fish to propagate here, because it is the strongest and hardiest species of fish in our waters.

EDGAR DASHIELL.

1. For twenty years.

2. Wicomico River.

3. No.

4. Shad spawn from May 15th to June 15th.

5. The catch of shad is now seventy-five per cent. less than it was twenty years ago.

6. I attribute the decrease to hauling seines during spawning season and to the spawn being eaten up by eels.

7. Shad, herring, rock, perch and taylors. Other fish might prosper if tried in our waters.

8. No.

9. No.

10. Yes. (Mr. Dashiell, the gentleman who filled this up, says that he has frequently caught female rock with roe, but not ripe.)

11. The largest was over eighty pounds.

13. I don't think rock are very destructive to other fish.

JOHN WILSON, *Landing Neck, Talbot County.*

1. I have fished for twenty-five years, more or less.

2. Have fished in Miles River occasionally, but for the last fifteen years principally in the Choptank.

3. I have to some extent.

4. They usually spawn about the last of April or the first of May. Some not before the fifteenth of May. They are most abundant about the last of April.

5. Have caught as many as 2,000 shad in one season, but for the last three years they have been scarce. Have kept no record of the temperature of the water, nor of the range of the wind, but have noticed that no fish are caught when the wind blows from the east.

6. Last season was a very poor one—worse than for many years past. Nothing like as good as some years back. I at-

tribute the falling off to the setting of pound nets in the lower Choptank and to fishing after the ripe shad begin to spawn.

7. I catch mostly shad. Perch and cat-fish are also caught.

8. Have kept no account of number and kinds caught. Used to keep an account of what each boat caught five years ago. They averaged then 2,000 to a boat. Last season the average was not above 500 each. Last season shad were twenty-five cents a piece, three years ago they were ten cents.

9. Have never caught a ripe female rock and have had no opportunity of observing the habits of rock-fish.

10. Have had no experience with ripe rock, male or female.

11. Sixty pounds. I know nothing of their growth.

12. The female is short and thick, the male is long and slender, but fully as large as the female.

13. I do not consider the rock a very destructive fish. It is one of the most profitable fish in our waters, as it can be caught in all seasons. It would be well to have our waters filled with them.

Andrew Towers.

1. Ten years.

2. Choptank River.

3. Yes.

4. From 1st to 10th of May.

5. Sixteen hundred shad in thirty days; winds box the compass.

6. A decrease. Cause—lake fishing in time of spawning.

7. Shad.

8. Shad average 15 cents, herring average 75 cents, rock, 5 cents per pound.

9. Yes.

10. The male predominates.

11. Seventy pounds.

12. Yes.

13. No.

WILLIAM FLETCHER, *Wicomico County.*

1. I have for thirty years.

2. In the Wicomico River.

3. I have.

4. They are more abundant about the last of April and the first of May than at any other time.

5. I do not.

6. The catch of shad was larger this year than for several years previous. I attribute the increase to the operations of the Fish Commission.

7. Shad, herring, rock, perch, pike, mullet, sun-perch, roach or butter-head, and cat-fish. Shad, herring, rock and perch are the principal fish caught in our river, and I think that they, with the black bass, are best adapted to our waters.

8. I have kept no account of fish sold, but think about one-eighth was rock, three-eighths shad, and the balance herring and small fish.

9. I have.

10. I have. It is a fact.

11. Forty pounds. I know nothing of their growth.

12. They differ in size. I know nothing of their growth.

13. I think not.

LEVIN MALONE, *Wicomico County.*

1. I have for twenty years.

2. In the Wicomico River.

3. I have.

4. They are more abundant about the last of April and the first of May than at any other time.

5. I do not.

6. The catch of shad was larger this year than for several years previous. I attribute this increase to the work of the Fish Commission.

7. Shad, herring, rock, perch, pike, mullet, roach and cat-fish. Shad, herring, rock and perch are the principal fish caught in our river, and I think that they, with the black bass, are best adapted to our waters.

8. I have kept no account of fish sold, but think about one-eighth rock, three-eighths shad, and the balance herring and small fish.

9. I have.

10. I have. It is a fact.

11. Ninety-five pounds. I know nothing of their growth per year.

12. I have noticed that the male rock is slenderer than the female.

13. No. I think the rock can be successfully propagated in our waters. They feed on such fish as the roach or butter-head, and those of large size sometimes eat herring in spring. They come up our river twice a year, *i. e.*, in the *spring* and *fall.*

James Willis, *Oxford, Talbot County, Md.*

1. Have fished for pleasure only, not for a livelihood, since 1829.

2. Tuckaho Creek, in Oxford, for the last twenty years.

3. No.

4. Usually spawn in March and up to June.

5. Cannot answer this question, as the wind has often been known to "box the compass" five or six times a day.

6. None, compared to what it was in 1831. Still decreasing, owing to the large number of haul, float and set seines and wier nets. Unless the necessary steps are taken to prevent further destruction we will have no shad in five years.

7. Rock, sturgeon, taylors, perch, sheeps-head, crocus, doutys-plenty, eels, thorny-backs, horse-mackerel, trout and pike.

8. No.

9. No.

10. No.

11. Twenty pounds.

12. Male rock is thin-gutted; female rock is large-gutted.

13. No.

John Meredith, *Cambridge, Dorchester County, Md.*

1. I have for nearly thirty years.
2. Choptank and Transquakin Rivers.
3. A good deal.
4. They spawn in latter part of April and in May.
5. I do not.
6. It has been better than last year or for several years past, but do not know to what to attribute it.
7. Shad, herring, rock and perch mostly. Also trout, taylors, pike and crocus. The first four are best adapted to our waters.
8. I have no account.
9. I do not know that I have.
10. I can hardly tell.
11. Three and a half to four feet. Don't know weight.
12. Female is thick; male slender.
13. I do not think so.

Tilghman H. Thomas.

1. For fourteen years.
2. Choptank River.
3. I have.
4. From the 2d of May to the 20th. In greater numbers before they are ripe.
5. No. From three to fifteen hundred. Temperature of water not known. Winds "box the compass."
6. Decrease; caused by the river being blockaded, keeping the fish from schooling, and also by catching them in spawning time.
7. Shad, herring, rock and cat-fish.
8. No. From three to fifteen hundred. Price for shad, ten cents to twenty-five cents; herring, seventy-five cents per hundred; rock, four cents per pound.
9. I don't know that I ever caught a ripe female rock.
10. I have caught numbers of ripe male rock.
11. Sixty-two pounds. I don't know how fast they grow

12. Sexes differ in respect to shape and size. Rate of growth not known.

13. Hav'nt given the question any consideration.

John W. Brown.

1. Twenty years.
2. Nanticoke River.
3. Yes.
4. Spawn about middle of May. More abundant before spawning season, say in April.
5. Catch from five to six thousand herring.
6. Better than for six or seven years. A hard winter is generally followed by a good fish season, as the fish that are kept back by the cold weather come in large numbers at the opening of the season.
7. Herring, perch, shad and rock. Same quantity of perch, herring and shad—not more than two hundred rock. I consider cat-fish and perch best suited to our waters.
9. I have seen rock spawn.
10. Males predominate in ratio of five to one.
11. Have caught a rock weighing fifty-five pounds. Cannot tell average growth per year.

Rock Fish—*Roccus lineatus.*

Our long search for a ripe rock was rewarded by the capture, by Dr. Capeheart, at the Scotch Hall Fishery, on the 6th of May, of three large females of this species with ripe spawn. They were landed about four o'clock in the afternoon, and immediately reported to William Hamlin, one of the experts of the Shad-hatching Corps. He stripped them, and the eggs taken filled two large pails of about six gallons each. This Fishery was about three miles distant from the hatching station, and he was not provided with the proper means of preserving the eggs. During their impregnation the pans used in shad-spawning were filled, and it was necessary to transport the eggs from the Fishing-shore to the central station in an almost solid mass. Mr. Hamlin reports

the eggs, when first spawned, to be of a pale-green color, slightly larger than those of herring; but becoming, after impregnation, somewhat larger than shad eggs, and losing their color and opaqueness, being transparent and almost invisible, an oily globule alone arresting the attention.

They were placed in the hatching vessels; some in the cylinders used for shad-hatching, some in the cones and others in floating boxes. While the eggs were being rinsed and manipulated, many hundreds of thousands of them were poured overboard at the wharf to which the steamer was moored. Quite a large number of them, however, apparently in good condition, were placed in the hatching vessels about midnight on the sixth. The following table shows the temperature of the air and water during the period covered by the hatching of these eggs:

DATE.	Temperature of — 6 A. M.				Temperature of — 12 M.				Temperature of — 6 P. M.			
	Air.	Surface Water.	Bottom Water.	Water in Cones.	Air.	Surface Water.	Bottom Water.	Water in Cones.	Air.	Surface Water.	Bottom Water.	Water in Cones.
May 6.......	68	65	65	65	82	71	69	69	69	71	70	70
May 7.......	68	67	67	66	61	67	67	66	60	68	67	67
May 8.......	56	63	64	62	67	66	65	64½	62	64½	64	64
May 9.......	56	64	62	62	67½	63	63	65	60	64	64	64

On the morning of the ninth almost all of the eggs were hatched, showing a much more rapid development than that of shad eggs under similar circumstances.

After being hatched, the fish were found to be considerably smaller than shad, but with much larger umbilical sacs. So small, in fact, were they, that it was impossible to confine them by the wire cloth used in the propagation of shad. Most of those hatched made their escape through the meshes of the wire cloth. Several thousands were dipped out from the hatching vessels and placed in transporting cans, and many of them were carried to Washington and some to Baltimore. The last mentioned were placed in the running water at the hatching house in Druid Hill Park. As a matter of experiment, several thousands of these young rock were placed in a tin pail on the deck of the steamer Lookout, and kept there without change of water. They were alive, and apparently healthy, ten days after being hatched. During a considerable part of the time they were on deck and exposed to the rays of the sun. This experiment shows that young rock can be much more easily transported than young shad; and that, in its earliest stages at least, it is a very hardy fish. This is an important consideration in view of the fact that, in order thoroughly to stock the waters of the State, the limited area of the spawning grounds of the rock may render it necessary to procure the eggs and hatch the fish at some point remote from the waters intended to be stocked.

The capture of these fish at so advanced a period in the season would seem to indicate that their spawning time is somewhat later than that of the shad. This may account for the failure, heretofore, to find ripe rock among those taken while fishing for shad and herring.

The fishing season in Albemarle Sound usually ends about the 1st of May, but during last spring the fisheries owned by Dr. Capcheart were continued to a somewhat later date. The table giving the details of shad-hatching operations on pages xxx to xxxiii show that the spawning season of shad in Albemarle Sound extends from the latter part of March to the first of May. We have not been able heretofore to find ripe shad

later than the period last mentioned, as the fisheries have closed on or before the 1st of May. Dr. Capeheart reports the young rock as appearing in large numbers in the month of August, in Salmon Creek, near the shad-hatching station. As the presence of large numbers of young rock has never been noticed in this locality before, it is probable that those referred to as appearing in the month of August were the product of the eggs obtained on the 6th of May, and artificially hatched; for, as already stated, many hundreds of thousands of eggs were thrown overboard while rinsing and manipulating them, and in addition, the vessels in which the rock were hatched were so constructed as to render their escape easy, as soon as they were freed from the eggs. It is matter of regret that the discovery of ripe rock—for which constant search had been made during six years—should have been so unexpected as to find us totally unprepared to make a thorough success of our experiments, or to observe the development of the eggs, with that care which their importance demands. We trust, however, that in the future we will have an opportunity of making a more careful study of this fish, and of hatching it on a scale sufficiently large to insure practical benefits therefrom.

SHAD—*Alosa sapadissima.*

The success which attended the experiment of establishing a shad hatching station on Albemarle Sound during the previous year caused Prof. Baird to desire a continuance of the work during last spring in North Carolina. Although our efforts to transfer the fish hatched at that point to Maryland waters had not proved successful, yet we deemed it of great importance to co-operate with Prof. Baird in this work, especially as it was a portion of his programme to remove his entire equipment from Albemarle Sound, at the close of the season in that latitude, to the Head of the Bay, and continue in Maryland waters the work of shad hatching. We did not propose to attempt the removal of the fish from that point to our own streams. Our object in desiring to assist the United States

Commissioner in effecting a large southern distribution from the fish produced in North Carolina was to enable him to devote to the stocking of our own waters a larger proportion of the fish obtained in Maryland than we could otherwise have secured. We, therefore, very readily contributed the use of the steamer Lookout and the apparatus arranged on her deck (described in a previous report); and we also transferred the trained men who were in the employ of the Maryland Commission, the U. S. Commissioner defraying their expenses and paying their wages during the shad-hatching season.

As the equipment referred to was a modification of that hitherto used, we give a representation of it in the frontispiece of this report.

Notwithstanding the fact that the main object in our cooperation with the United States Commissioner was to enable him to devote a larger percentage of fish produced in Maryland waters to stocking our own streams than would otherwise have been possible, yet as the United States Commission was willing to turn over to us what fish we wished for Maryland waters, we secured two shipments of about 300,000 each, which we endeavored to transfer to the waters of the Eastern Shore by steamer from Norfolk. The steamer Lookout being fully engaged in producing the fish, we communicated with His Excellency, Governor Carroll, presiding over the Board of State Fishery Force, and obtained from him the detail of the steamer Lelia, which proceeded to Norfolk for the purpose of transferring these fish, arriving there on the 6th day of May. We had hoped to secure the services of the Lelia immediately after the close of the oyster season, but from some cause she was delayed until the above-mentioned date; and unfortunately, upon the very day of her arrival at Norfolk, a violent easterly storm set in and continued for nearly a week. The young fish placed in charge of Mr. Thomas Hughlett, Jr., on board the Lelia, and although no effort was spared by this young gentleman to keep them in good condition, they all died before the weather permitted the steamer to leave port. It affords us pleasure to give the testimony contained in letters received

from Captain Travers, commanding the steamer, and Colonel Hines, the former commander, who was on board, testifying to the faithful discharge of duty by Mr. Hughlett.

BALTIMORE, May 15, 1879.

T. B. FERGUSON, ESQ.

DEAR SIR: I was on the steamer Lelia last week when she was down the bay for the purpose of carrying your young shad to the Eastern Shore rivers.

The weather was exceedingly rough from the time we reached Norfolk until Monday last, and though Mr. Hughlett took every pains and care of the young fish sent him, they died before Sunday.

I looked into the cans when they were first received at Norfolk, and found some dead ones, but though he regularly every second hour, night and day, carefully drew from the cans about two gallons of water and supplied a like fresh amount from the steamer's tanks, attending to it himself, trusting to no one to do it, they, after the run from Norfolk to Fortress Monroe, when we had to harbor on account of the heavy sea, began to die very rapidly.

This trip of Mr. Hughlett was, he told me, the first he had taken with young fish, and I have written this letter that you might understand that the failure to get the fish to their destination was due in no way either to him or Captain Travers, who gave him every assistance in his power, but to the weather and causes beyond the control of man.

Respectfully yours, JESSE K. HINES.

T. B. FERGUSON. NORFOLK, VA.

DEAR SIR: Yours of the 7th, and also nine tins of young shad, came to hand in due time. I can only say, as soon as we could procure sufficient water for the fish we proceeded on our voyage to Crisfield. When we got as far as Fortress Monroe we found the wind and sea too much for such a ship as the Lelia, and went into Old Point and remained until the morning; and Mr. Hughlett, finding his fish over two-thirds dead, and no prospect of us being able to

cross the bay, he concluded to return to this place and await a fresh supply. Should the weather continue boisterous we will not be able to render you the assistance that I much desire to do. Yours truly, SAMUEL M. TRAVERS.

No other attempts were made to transfer the fish from the North Carolina Hatching Station to Maryland waters during the season, as we deemed it best for the interests of the State to postpone the acceptance of any aid which the United States Commission might be disposed to render us until the opening of our season, and the removal of operations to the "Head of the Bay."

Although our efforts during these two years to remove the fish from this station, where they are produced in such large numbers, resulted in comparative failure, we have gained most valuable experience, and have devised apparatus in which the fish can be readily transferred when it becomes necessary to repeat the attempt.

We deem it proper to call your attention to the following table (which the courtesy of the United States Commissioner enables us to produce) showing in detail the shad-hatching operations conducted on Albemarle Sound, as the services of the steamer Lookout and the apparatus contributed, as well as the detail of the men above-mentioned, have in a great measure identified the Maryland Commission with this important work:

RECORD OF SHAD HATCHING OPERATIONS *conducted in Salmon Creek, Albemarle Sound, on the Steamer Lookout, at Avoca Wharf, from April 11th, 1879, to May 14th, 1879, on account of United States and Maryland Commissions, by John S. Saunders.*

Date.	Temperature of									Wind.						Condition of	
	6 A. M.			12 M.			6 P. M.			6 A. M.		12 M.		6 P. M.		Sky.	
	Air.	Surface water.	Bottom.	Air.	Surface water.	Bottom.	Air.	Surface water.	Bottom.	Direction.	Intensity.	Direction.	Intensity.	Direction.	Intensity.	6 A. M.	12 M.
April 11.	....	....	....	50	54	54	....	....	....	N E.	Strong.	N.E.	Strong.	N.E.	Strong.	....	Overcs't
" 12.	....	....	....	49	55	54	....	....	....	S.	Strong.	S.	Strong.	S.	Strong.	....	Clear.
" 14.	56	57	57	68	59	59	62	59	59	S. to E.	Light.	S. to E.	Light.	S. to E.	Light.	Thun, Li	g.& Rain
" 15.	59	57	57	73	59	60	71	61	61	S W.	Strong.	S.W.	Strong.	S.W.	Strong.	Clear.	Clear.
" 16.	60	60	59	68	62	60	63	60	60	S to N E	Variable	S.to N.E	Variable	S toN.E.	Variable	Cloudy&	Raining
" 17	64	60	60	62	59	59	65	60	60	S. to W.	Variable	S. to W.	Variable	S to W.	Variable	Raining	Raining.
" 18.	45	56	55	59½	58	58	52	58	57	N.W.	Strong.	N.W.	Strong.	N.W.	Strong.	Overcs't.	Overcs't
" 19	47	56	56	59	58	58	55	58	58	N.W.	Heavy.	N.W.	Heavy.	N.W.	Heavy.	Clear.	Clear.
" 20.	45	56	55	64	60½	59	63	60	60	N.E.	Gentle.	N.E.	Gentle.	N.E.	Gentle.	Clear.	Clear.
" 21.	52	58	58	71	64	61	70	65	66	N.E.	Gentle.	N E.	Gentle.	N E.	Gentle.	Clear.	Clear.
" 22.	59	60	60	72	66	65	70	70	69	N.E.	Gentle.	N E.	Gentle.	N.E.	Gentle.	Clear.	Clear.
" 23.	56	64	63	82	72	70	79	69	68	S.W.	Gentle.	S.W.	Gentle.	S W.	Gentle.	Clear.	Clear.
" 24	54	59	58	63	64	63	62	64	63	N E.	Strong.	N.E.	Strong.	N.E.	Strong.	Clear.	Clear.
" 25.	50	60	55	73	69	63	76	67	66	N W.	Gentle.	N.W.	Gentle.	N.W.	Gentle.	Clear.	Clear.
" 26.	66	64	63	86	70	67	83	68	67	S.W.	Light.	S.W.	Light.	S.	Light.	Clear.	Clear.

"	27.	68	67	65	83	68	67	75	66	64	S.	Light.	S.	Light.	S.	Light.	Clear.	Clear.
"	28	66	64	64	79	65	64	63	65	63	S.	Calm.	S.	Calm.	S.	Calm.	Overcs't.	Raining
"	29.	64	65	65	67	66	65	66	66	66	N.E.	Light.	N E.	Light.	N.E.	Light.	Overcs't.	Overcs't
"	30.	65	64	63½	75	69	68	74	68	67	N.W.	Light.	N.W.	Light.	N.W.	Light.	Clear.	Clear.
May	1.	54	64	64	60	63	63	57	63	63	N.E.	Light.	N.E.	Light.	N.E.	Light.	Overcs't.	Showery
"	2.	56	64	64	72	65	64	62	63½	65	N.E.	Light.	N.E.	Light.	N E.	Light.	Clear.	Clear.
"	3.	55	63	63	66	66	65½	64	67	66	E.	Light.	E.	Light.	S.E.	Light.	Clear.	Clear.
"	4.	66	65	65	80	68	67	70	65	66	S.	Strong.	S.	Strong.	S.	Strong.	Clear.	Clear.
"	5.	70	66	66	82	68	67	70	69	68	S.W.	Gentle.	S.W.	Gentle.	S.W.	Gentle.	Clear.	Clear.
"	6	68	65	65	82	71	69	69	71	70	S.E.	Gentle.	S.E.	Gentle.	S.E.	Gentle.	Clear.	Clear.
"	7.	68	67	67	61	67	67	60	68	67	N.E.	Strong.	N E.	Strong.	N.E.	Strong.	Raining.	Raining
"	8.	56	63	64	67	66	65	62	64½	64	N.E.	High.	N.E.	High.	N E.	High.	Clear.	Clear.
"	9.	56	64	62	67½	63	63	60	64	64	N.E.	Gale.	N.E.	Gale.	N.E.	Gale.	Clear.	Clear.
"	10.	57	62	62	61	63	63	60	63	63	N.E.	Gale.	N.E.	Gale.	N.E.	Gale.	Overcs't	Overcs't.
"	11.	65	61	62	78	66	65	68	65	65	E.	Gentle.	S.E.	Gentle.	S.E.	Gentle.	Overcs't.	Overcs't

RECORD OF SHAD HATCHING OPERATIONS *conducted in Salmon Creek, Albemarle Sound, on the Steamer Lookout, at Avoca Wharf, from April 11th, 1879, to May 14th, 1879, on account of United States and Maryland Commissions, by John S. Saunders.*

Date.	Temperature of									Wind.						Condition of	
	6 A. M.			12 M.			6 P. M.			6 A. M.		12 M.		6 P. M.		Sky.	
	Air.	Surface water.	Bottom.	Air.	Surface water.	Bottom.	Air.	Surface water.	Bottom.	Direction.	Intensity.	Direction.	Intensity.	Direction.	Intensity.	6 A. M.	12 M.
April 11.	....	....	....	50	54	54	....	....	....	N E.	Strong.	N.E.	Strong.	N.E.	Strong.	....	Overes't
" 12.	...	....	....	49	55	54	...	....	....	S.	Strong.	S.	Strong.	S.	Strong.	....	Clear.
" 14.	56	57	57	68	59	59	62	59	59	S. to E.	Light.	S. to E.	Light.	S. to E.	Light	Thun, Li	g.& Rain
" 15.	59	57	57	73	59	60	71	61	61	S W.	Strong.	S.W.	Strong.	S.W.	Strong.	Clear.	Clear.
" 16	60	60	59	68	62	60	63	60	60	S to N E	Variable	S.to N E	Variable	S toN.E.	Variable	Cloudy&	Raining
" 17	64	60	60	62	59	59	65	60	60	S to W.	Variable	S. to W.	Variable	S to W.	Variable	Raining	Raining.
" 18.	45	56	55	59½	58	58	52	58	57	N W.	Strong.	N.W.	Strong.	N.W.	Strong.	Overes't	Overes't
" 19	47	56	56	59	58	58	55	58	58	N.W.	Heavy.	N.W.	Heavy.	N W.	Heavy.	Clear.	Clear.
" 20.	45	56	55	64	60½	59	63	60	60	N E.	Gentle.	N.E.	Gentle.	N E.	Gentle.	Clear.	Clear.
" 21	52	58	58	71	64	61	70	65	66	N.E.	Gentle.	N E.	Gentle.	N E.	Gentle.	Clear.	Clear.
" 22.	59	60	60	72	66	65	70	70	69	N.E.	Gentle.	N E.	Gentle.	N.E.	Gentle.	Clear.	Clear.
" 23.	56	64	63	82	72	70	79	69	68	S.W.	Gentle.	S.W.	Gentle.	S W.	Gentle.	Clear.	Clear.
" 24	54	59	58	63	64	63	62	64	63	N E.	Strong.	N.E.	Strong.	N.E.	Strong.	Clear.	Clear.
" 25	50	60	55	73	69	63	76	67	66	N W.	Gentle.	N.W.	Gentle.	N.W.	Gentle.	Clear.	Clear.
" 26.	66	64	63	86	70	67	83	68	67	S.W.	Light.	S.W.	Light.	S.	Light.	Clear.	Clear.
" 27.	68	67	65	83	68	67	75	66	64	S.	Light.	S.	Light.	S.	Light.	Clear.	Clear.
" 28	66	64	64	79	65	64	63	65	63	S.	Calm.	S.	Calm.	S.	Calm.	Overes't.	Raining
" 29.	64	65	65	67	66	65	66	66	66	N E.	Light.	N E.	Light.	N.E.	Light.	Overes't.	Overes't
" 30.	65	64	63½	75	69	68	74	68	67	N.W.	Light.	N.W.	Light.	N.W.	Light.	Clear.	Clear.
May 1.	54	64	64	60	63	63	57	63	63	N.E.	Light.	N.E.	Light.	N.E.	Light.	Overes't.	Showery
" 2.	56	64	64	72	65	64	62	63½	65	N.E.	Light.	N.E.	Light.	N E.	Light.	Clear.	Clear.
" 3.	55	63	63	66	66	65½	64	67	66	E.	Light.	E.	Light.	S.E.	Light.	Clear.	Clear.
" 4.	66	65	65	80	68	67	70	65	66	S.	Strong.	S.	Strong.	S.	Strong.	Clear.	Clear.
" 5.	70	66	66	82	68	67	70	69	68	S.W.	Gentle.	S.W.	Gentle	S W.	Gentle.	Clear.	Clear.
" 6	68	65	65	82	71	69	69	71	70	S E.	Gentle.	S.E.	Gentle.	S.E.	Gentle.	Clear.	Clear.
" 7.	68	67	67	61	67	67	60	68	67	N.E.	Strong.	N E.	Strong	N E.	Strong.	Raining.	Raining
" 8.	56	63	64	67	66	65	62	64½	64	N.E.	High.	N.E.	High.	N E.	High.	Clear.	Clear.
" 9.	56	64	62	67½	63	63	60	64	64	N.E.	Gale.	N E.	Gale.	N.E.	Gale.	Clear.	Clear.
" 10.	57	62	62	61	63	63	60	63	63	N.E.	Gale.	N.E.	Gale.	N E.	Gale.	Overes't	Overes't.
" 11.	65	61	62	78	66	65	68	65	65	E.	Gentle.	S.E.	Gentle.	S.E.	Gentle.	Overes't.	Overes't

RECORD OF SHAD HATCHING OPERATIONS *conducted in Salmon Creek, Albemarle Sound, on the Steamer Lookout, at Avoca Wharf, from April 11th, 1879, to May 14th, 1879, on account of United States and Maryland Commissions, by John S. Saunders*—Continued.

Date.	Condition of Sky. 6 P. M.	Condition of Water.	Name of Fisheries Visited.	No. of Hauls Attended.	Total Number of Fish Taken at Hauls Attended. Shad.	Herring.	Pounds of Rock.	Ripe Fish. Shad. Males.	Female.	Eggs Obtained.	Fish Hatched.
April 11.	....	Muddy.	*A	1	199	600	....	5	3	50,000	....
" 12.	....	Muddy.	A	1	438	6,000	....	14	10	250,000	....
" 14.	Thun, Lig & Rain.	Cloudy.	A	2	224	9,000	94	5	3	60,000	....
" 15.	Clear.	Cloudy.	A	2	523	7,500	240	6	3	60,000	....
" 16.	Cloudy & Raining.	Cloudy.	A2 SH1	3	734	17,000	225	7	3	60,000	....
" 17.	Raining.	Cloudy.	A2 SH1	3	1,825	21,000	395	14	6	120,000	....
" 18.	Overcast.	Cloudy.	A2 SH4	6	3,286	39,900	945	14	7	110,000	....
" 19.	Clear.	Cloudy.	A2 SH3	5	1,112	30,000	856	6	3	50,000	....
" 20.	Clear.	Clearing.	†..........	....	....	....	....	....	....	....	....
" 21.	Clear.	Clear.	A3 SH4	7	3,219	89,000	1,058	28	17	420,000	....
" 22.	Clear.	Clear.	A2 SH2	4	808	40,500	650	15	10	240,000	....
" 23.	Clear.	Clear.	A2 SH3	5	4,078	27,500	925	18	12	250,000	....
" 24.	Clear.	Clear.	A2 SH3	5	2,133	24,500	1,080	39	25	605,000	140,000

"	25.	Clear.	Clear.	A1 SH2 P2	5	1,622	62,000	322	19	8	185,000	200,000
"	26.	Overcast.	Clear.	A3 SH3 P2	8	2,227	38,800	1,085	20	8	175,000	350,000
"	27.	Clear	Clear.	†..........	....	....	....	....	....	....	....	....
"	28.	Clearing.	Muddy.	A4 SH2 P3	9	3,760	81,500	1,082	33	20	445,000	325,000
"	29.	Clear.	Muddy.	A2 SH2 P2	6	3,630	25,000	693	53	37	850,000	400,000
"	30	Clear.	Clearing.	A2 P1	3	1,460	66,500	240	37	25½	565,000	....
May	1.	Showery.	Clearing.	A1 P2	3	1,960	148,000	410	24	17½	400,000	520,000
"	2.	Clear.	Clearing.	A1 P1	2	675	14,000	195	28	25	625,000	200,000
"	3	Clear.	Clearing.	A1 P2	3	488	71,000	300	13	10	250,000	150,000
"	4.	Clear.	Clear.	†..........	....	....	....	....	....	....	....	....
"	5.	Showery.	Clear.	A1 SH2 P1	4	695	62,000	1,015	25	19	410,000	500,000
"	6.	....	....	....	....	....	....	....	Rock 2	Rock 2	Rock 1,000,000	
"	6.	Clear.	Muddy.	A1 SH2 P1	4	708	8,500	890	16	13	260,000	440,000
"	7.	Overcast.	Muddy.	A1 SH3	4	1,626	13,500	700	27	24	500,000	425,000
"	8.	....	....	....	....	....	....	....	....	....	25 p. c. bad eggs(dead.)	
"	8.	Clear.	Muddy.	A1	1	1,140	25,000	230	30	25	500,000	230,000
"	9.	Clear.	Muddy.	‡..........	....	....	....	....	....	....	....	....
"	10.	Overcast.	Clear.	A2	2	842	17,500	340	....	....	....	....
"	11.	Clear.	Clear.	†..........	....	....	....	....	....	....	....	....
"	12.	....	....	....	....	....	....	....	....	....	....	665,000
"	13.	....	....	....	....	....	....	....	....	....	....	500,000
"	14.	....	....	....	....	....	....	....	....	....	....	250,000
					98	39,412	945,800	13,970	496	334	7,440,000	5,295,000

* Dr. Capehart has changed the name of *Sutton Beach* to AVOCA, and wishes it so entered.

† Sunday. Seines not worked.

‡ No Fisheries hauling. Heavy gale, N.E.

RECORD OF SHAD HATCHING OPERATIONS *conducted in Salmon Creek, Albemarle Sound, on the Steamer Lookout, at Avoca Wharf, from April 11th, 1879, to May 14th, 1879, on account of United States and Maryland Commissions, by John S. Saunders*—Continued.

Date.	Condition of		Name of Fisheries Visited.	No. of Hauls Attended.	Total Number of Fish Taken at Hauls Attended.			Ripe Fish. Shad.		Eggs Obtained.	Fish Hatched.
	Sky. 6 P. M.	Water.			Shad.	Herring.	Pounds of Rock.	Males.	Female.		
April 11.	....	Muddy.	*A	1	199	600	....	5	3	50,000	....
" 12.	....	Muddy.	A	1	438	6,000	....	14	10	250,000	....
" 14.	Thun. Lig & Rain.	Cloudy.	A	2	224	9,000	94	5	3	60,000	....
" 15.	Clear.	Cloudy.	A	2	523	7,500	240	6	3	60,000	....
" 16	Cloudy & Raining.	Cloudy.	A2 SH1	3	734	17,000	225	7	3	60,000	....
" 17.	Raining.	Cloudy.	A2 SH1	3	1,825	21,000	395	14	6	120,000	....
" 18	Overcast.	Cloudy.	A2 SH4	6	3,286	39,900	945	14	7	110,000	....
" 19.	Clear.	Cloudy.	A2 SH3	5	1,112	30,000	856	6	3	50,000	....
" 20.	Clear.	Clearing.	†..........	...	....	....	....	....	....	....	....
" 21.	Clear.	Clear.	A3 SH4	7	3,219	89,000	1,058	28	17	420,000	....
" 22.	Clear.	Clear.	A2 SH2	4	808	40,500	650	15	10	240,000	....
" 23.	Clear.	Clear.	A2 SH3	5	4,078	27,500	925	18	12	250,000	....
" 24.	Clear.	Clear.	A2 SH3	5	2,133	24,500	1,080	39	25	605,000	140,000
" 25.	Clear.	Clear.	A1 SH2 P2	5	1,622	62,000	322	19	8	185,000	200,000
" 26.	Overcast.	Clear.	A3 SH3 P2	8	2,227	38,800	1,085	20	8	175,000	350,000
" 27.	Clear	Clear.	†..........	...	....	....	....	....	....	....	....
" 28.	Clearing.	Muddy.	A4 SH2 P3	9	3,760	81,500	1,082	33	20	445,000	325,000
" 29.	Clear.	Muddy.	A2 SH2 P2	6	3,630	25,000	693	53	37	850,000	400,000
" 30	Clear.	Clearing.	A2 P1	3	1,460	66,500	240	37	25½	565,000	....
May 1.	Showery.	Clearing.	A' P2	3	1,960	148 000	410	24	17½	400,000	520,000
" 2.	Clear.	Clearing.	A1 P1	2	675	14,000	195	28	25	625,000	200,000
" 3	Clear.	Clearing.	A1 P2	3	488	71,000	300	13	10	250,000	150,000
" 4.	Clear.	Clear.	†..........	...	....	....	....	....	....	....	....
" 5.	Showery.	Clear.	A1 SH2 P1	4	695	62,000	1,015	25	19	410,000	500,000
" 6	....	....	....	...	....	....	....	Rock } 2	Rock } 2	Rock } 1,000,000	
" 6.	Clear.	Muddy.	A1 SH2 P1	4	708	8,500	890	16	13	260,000	440,000
" 7.	Overcast.	Muddy.	A1 SH3	4	1,626	13,500	700	27	24	500,000	425,000
" 8.	....	....	....	...	....	....	....	....	....	25 p c. bad eggs(dead.)	
" 8.	Clear.	Muddy.	A1	1	1,140	25,000	230	30	25	500,000	230,000
" 9.	Clear.	Muddy.	‡..........	...	....	....	....	....	....	....	....
" 10.	Overcast.	Clear.	A2	2	842	17,500	340	....	....	....	....
" 11.	Clear.	Clear.	†..........	...	....	....	....	....	....	....	....
" 12.	....	....	....	...	....	....	....	....	....	....	665,000
" 13.	....	....	....	...	....	....	....	....	....	....	500,000
" 14.	....	....	....	...	....	....	....	....	....	....	250,000
				98	39,412	945,800	13,970	496	334	7,440,000	5,295,000

* Dr. Capehart has changed the name of *Sutton Beach* to Avoca, and wishes it so entered.

† Sunday. Seines not worked.

‡ No Fisheries hauling. Heavy gale, N.E.

The U. S. Commissioner determined to rely entirely on the apparatus taken down by the Lookout for perfecting the eggs gathered at the North Carolina station. We, therefore, retained in Maryland waters, the barges which had been used in the shad-hatching operations, as we thus insured their being available at the opening of the spawning season at Havre de-Grace. They were anchored in the position held by them in previous years, in Spesutie Narrows; and on board was placed a portion of the hatching corps, with instructions to examine the fish daily taken by the haul seines and gill-nets and report the arrival of the first spawning fish. The first ripe female was secured on the 3rd of May.

From this time the corps continued the examination of the seines on Spesutie Island and some of the floating batteries on the Flats. They also examined nightly the shad taken with the gill-nets. Although the number of ripe fish varied each night, they increased gradually until about the 23rd of the month.

From this period up to the end of May the operators were more successful than at any other time.

An examination of the table will show that the temperature of the water varied from 68° to 72°; and during this period the number of eggs secured, each night, was over half a million.

Near the end of May a second barge, fitted with the machinery which had been used in Albemarle Sound, was ready for work; and, with a portion of the corps, was placed in charge of Mr. John S. Saunders, who had conducted the operations in North Carolina. This second machinery-barge was anchored in the channel, near the Old Bay-fishery, and the operators attached to it were instructed to examine the fish taken by the gillers in this inner channel and on the upper portions of the Flats.

The machinery-barge, which had been successfully worked the year previous, was kept in Spesutie Narrows, in the old quarters, and was placed in charge of Mr. F. N. Clark, an experienced fish culturist. The details of the operations at these two stations will be found in the accompanying tables.

The work of collecting the eggs and hatching them out was continued with great success until the 10th of June, when the fishing in Maryland waters ceases by limitation of law. During the forty-five days in which the work was conducted by Mr. Clark, the force under his direction examined numbers of shad, finding about 503 ripe females, from which they secured 11,015,000 eggs. Over 9,515,000 fish were produced from these eggs, and were either deposited in the local streams or shipped to other waters.

In the period of thirteen days consumed in similar work by the corps on machinery-barge No. 2, under Mr. John S. Saunders, of Baltimore, the men examined 4,859 shad, and found 112 ripe females. From these fish, by using the milt from 119 males, they obtained 1,900,000 eggs, hatching out 1,252,000 young fish, most of which were placed in local waters. The tables accompanying this report show in detail the work at the three stations.

On the 4th of May all the eggs secured before the close of the fishing season at Havre de Grace were hatched out, and the machinery and equipment towed to Baltimore harbor and stored. The estimates of eggs and fish were based on the supposition that a healthy ripe shad would produce 20,000 eggs. During the season Mr. Clark studied the subject with care. Having counted the number of eggs that would cover a square inch of space, and calculating therefrom the total yield of several good fish, he found that the average would be nearer 30,000 than 20,000. It has, however, been the custom with the Maryland Commission to take the last-mentioned number as the basis of calculation.

From an examination of the reports of the New York Commissioners, we find that they estimate the yield of shad on the Hudson River at a much higher figure.

Of the fish produced at Havre de Grace, 7,757,000 were deposited in the waters of Maryland.

RECORD OF SHAD HATCHING OPERATIONS *conducted at Spesutie Narrows,*
States and Maryland Fish Com

Date.	Temperature of: Air. 6 A. M.	Surface water. 6 A. M.	Air. 12 M.	Surface water. 12 M.	Air. 6 P. M.	Surface water. 6 P. M.	Wind. Direction. 6 A. M.	Intensity. 6 A. M.	Direction. 12 M.	Intensity. 12 M.
May 1	....	....	....	57	....	....	....	....	....	....
" 2	....	....	....	58	....	....	....	....	....	....
" 3	....	....	....	60	....	....	....	....	....	....
" 4	....	....	....	57	....	....	....	....	....	....
" 5	....	....	....	61	....	....	....	....	....	....
" 6	....	....	....	62	....	....	....	....	....	....
" 7	....	....	....	63	....	....	....	....	....	....
" 8	....	....	....	65	....	....	....	....	....	....
" 9	....	....	....	64	....	....	....	....	....	....
" 10	....	....	....	62	....	....	....	....	....	....
" 11	....	....	....	62	....	....	....	....	....	....
" 12	....	....	....	65	....	....	....	....	....	....
" 13	....	....	70	67	....	....	....	....	S.	Light.
" 14	....	....	80	72	....	....	....	....	S.E.	Light.
" 15	....	....	76	72	....	....	....	....	S.W.	Strong.
" 16	....	....	82	73	....	....	....	....	S.E.	Light.
" 17	70	71	79	73	78	73	E.	Strong.	N.E.	Strong.
" 18	72	71	76	73	69	73	N.E.	Light.	N.E.	Light.
" 19	70	71	76	75	78	77	S.	Light.	S W.	Light.
" 20	69	71	79	75	76	75	S.	Light.	S.E.	Light.
" 21	69	70	76	76	70	75	S.W.	Light.	S.W.	Strong.
" 22	68	71	71	72	68	72	N.W.	Gale.	N.E.	Strong.
" 23	60	67	65	68	66	69	N.E.	Strong.	N E.	Strong.
" 24	66	64	68	66	65	68	S.W.	Light.	S.W.	Strong.
" 25	60	67	72	69	69	72	W.	Light.	S W.	Strong.
" 26	66	68	70	69	70	70	N.E.	Strong.	N.E.	Strong.
" 27	60	68	66	66	67	67	E.	Light.	S	Strong.
" 28	66	66	74	69	70	70	N.	Strong.	N.E.	Light.
" 29	66	66	74	71	74	71	W.	Light.	S.W.	Light.
" 30	69	68	82	72	83	73	S.	Very Light	S.W.	Light.
" 31	73	71	80	75	90	75	S.	Light.	S.	Light.
June 1	75	74	86	77	93	82	S.W.	Very Light	S W.	Very Light
" 2	82	76	88	79	86	81	W.	Very Light	S.W.	Very Light
" 3	80	77	74	77	76	78	N.W.	Very Light	S.W.	Very Light
" 4	66	76	68	76	78	78	W.	Very Light	W.	Very Light
" 5	75	74	82	78	74	77	S.W.	Very Light	S.W.	Very Light
" 6	79	76	80	78	74	78	N.W.	Very Light	N.W.	Very Light
" 7	58	69	64	69	68	74	N.W.	Strong.	N.	Light.
" 8	74	72	78	73	80	76	N.	Very Light	N.W.	Very Light
" 9	75	73	76	74	85	78	N.E.	Very Light	S.	Very Light
" 10	76	74	82	78	79	77	S.W.	Very Light	S.	Fair.
" 11	74	75	85	79	74	77	S.W.	Fair.	S.W.	Fair.
" 12	70	75	78	78	78	79	S.W.	Light.	S.E.	Light.
" 13	73	76	77	78	74	76	N.W.	Strong.	N.	Strong.
" 14	69	75	78	78	....	....	N.	Strong.	S.	Fair

on the Chesapeake Bay, from May 1*st*, 1879, *to June* 14*th*, 1879, *on account of the United missions, by Frank N. Clark.*

Wind: Direction.	Wind: Intensity.	Condition of Sky.			Condition of Water.	Ripe Fish.		Eggs Obtained.	Fish Htch'd.
6 P. M.	6 P. M.	6 A. M.	12 M.	6 P. M.		Males.	Females.		
....	....	....	....	....	....	...	...	....	....
....	....	....	....	....	....	...	...	....	....
....	....	....	....	....	....	1	1	25,000	....
....	....	....	....	....	....	...	...	....	....
....	....	....	....	....	....	2	2	45,000	....
....	....	....	....	....	....	...	...	....	....
....	....	....	....	....	....	6	6	130,000	....
....	....	....	....	....	....	1	1½	35,000	....
....	....	....	....	....	....	5	5	110,000	....
....	....	....	....	....	....	2	2	45,000	....
....	....	....	....	....	....	...	...	....	....
....	....	....	....	....	....	15	15	325,000	....
....	....	....	Hazy.	....	Clear.	8	8	170,000	....
....	....	....	Cloudy.	....	Clear.	10	10	225,000	....
....	....	....	Clear.	....	Clear.	9	9	190,000	....
....	....	....	Clear.	....	Clear.	2	2	45,000	300,000
N.E.	Strong.	Cloudy.	Cloudy.	Cloudy.	Clear.	14	14	310,000	140,000
S.E.	Strong.	Cloudy.	Cloudy.	Cloudy.	Clear.	6	6	130,000	375,000
S.W.	Light.	Cloudy.	Clear.	Cloudy.	Clear.	10	10	225,000	300,000
S.E.	Light.	Cloudy.	Cloudy.	Clear	Clear.	14	14	310,000	200,000
N.E.	Gale.	Cloudy.	Clear.	Cloudy.	Clear.	...	...	....	300,000
N.E.	Strong.	Clear.	Clear.	Clear.	Cloudy.	9	9	195,000	200,000
S.E.	Light.	Clear.	Clear.	Clear.	Clear.	22	22	475,000	100,000
S.W.	Strong.	Clear.	Clear.	Clear.	Clear.	27	27	590,000	150,000
N.W.	Strong.	Cloudy.	Clear.	Cloudy.	Clear.	30	30	660,000	100,000
N.	Light.	Clear.	Cloudy.	Cloudy.	Clear.	30	30	665,000	150,000
S.	Light.	Cloudy.	Cloudy.	Cloudy.	Clear.	36	36	795,000	100,000
S.	Light.	Clear.	Clear.	Clear.	Clear.	25	25	550,000	425,000
S.W.	Light.	Clear.	Clear.	Cloudy.	Clear.	25	25	545,000	450,000
S.W.	Light.	Cloudy.	Clear.	Clear.	Clear.	27	27	600,000	950,000
S.W.	Very Light	Clear.	Clear.	Clear.	Clear.	15	15	330,000	900,000
S.W.	Very Light	Clear	Clear.	Clear.	Clear.	17	17	385,000	950,000
S.	Very Light	Clear.	Clear.	Cloudy.	Clear.	2	2	45,000	725,000
S.	Very Light	Cloudy.	Cloudy.	Cloudy.	Clear.	17	17	300,000	325,000
W.	Very Light	Slig'y "	Clear.	Clear	Clear.	30	30	665,000	150,000
N.	Strong.	Clear.	Clear.	Cloudy.	Clear.	15	15	360,000	....
N.W.	Strong.	Clear.	Clear.	Cloudy.	Clear.	10	10	225,000	100,000
N.W.	Light.	Clear.	Clear.	Clear.	Clear.	20	20	410,000	325,000
S.	Very Light	Clear.	Clear.	Clear.	Clear.	11	11	255,000	300,000
S.	Very Light	Clear.	Clear.	Clear.	Clear.	6	6	115,000	275,000
S.	Fair.	Clear.	Clear.	Clear.	Clear.	...	...	....	350,000
S.W.	Strong.	Clear.	Clear.	Clear.	Clear.	10	10	220,000	325,000
S.W.	Light	Clear.	Clear.	Clear.	Clear.	14	14	310,000	200,000
N.W.	Strong.	Clear.	Clear.	Clear.	Clear.	...	...	....	100,000
....	....	....	....	....	....	...	...	....	250,000
						503	503	11,015,000	9,515,000

Remarks.—Sent to Havre de Grace by Quinn 100,000; sent to Havre de Grace for Kumlein 50,000; station moved to Havre de Grace with 400,000 eggs on hand. Total 550,000.

RECORD OF SHAD HATCHING OPERATIONS *conducted at Spesutie Narrows, on the Chesapeake Bay, from May 1st, 1879, to June 14th, 1879, on account of the United States and Maryland Fish Commissions, by Frank N. Clark.*

Date.	Temperature of Air, 6 A. M.	Surface water, 6 A. M.	Air, 12 M.	Surface water, 12 M.	Air, 6 P. M.	Surface water, 6 P. M.	Wind 6 A. M. Direction.	Wind 6 A. M. Intensity.	Wind 12 M. Direction.	Wind 12 M. Intensity.	Wind 6 P. M. Direction.	Wind 6 P. M. Intensity.	Condition of Sky 6 A. M.	Sky 12 M.	Sky 6 P. M.	Water.	Ripe Fish. Males.	Ripe Fish. Females.	Eggs Obtained.	Fish Hatch'd.
May 1				57																
" 2				58																
" 3				60													1	1	25,000	
" 4				57																
" 5				61													2	2	45,000	
" 6				62																
" 7				63													6	6	130,000	
" 8				65													1	1½	35,000	
" 9				64													5	5	110,000	
" 10				62													2	2	45,000	
" 11				62																
" 12				65													15	15	325,000	
" 13			70	67					S.	Light.				Hazy.		Clear.	8	8	170,000	
" 14			80	72					S.E.	Light.				Cloudy.		Clear.	10	10	225,000	
" 15			76	72					S.W.	Strong.				Clear.		Clear.	9	9	190,000	
" 16			82	73					S.E.	Light.				Clear.		Clear.	2	2	45,000	300,000
" 17	70	71	79	73	78	73	E.	Strong.	N.E.	Strong.	N.E.	Strong.	Cloudy.	Cloudy.	Cloudy.	Clear.	14	14	310,000	140,000
" 18	72	71	76	73	69	73	N.E.	Light.	N.E.	Light.	S.E.	Strong.	Cloudy.	Cloudy.	Cloudy.	Clear.	6	6	130,000	375,000
" 19	70	71	76	75	78	77	S.	Light.	S W.	Light.	S.W.	Light.	Cloudy.	Clear.	Cloudy.	Clear.	10	10	225,000	300,000
" 20	69	71	79	75	76	75	S.	Light.	S.E.	Light.	S.E.	Light.	Cloudy.	Cloudy.	Clear	Clear.	14	14	310,000	200,000
" 21	69	70	76	76	70	75	S.W.	Light.	S.W.	Strong.	N.E.	Gale.	Cloudy.	Clear.	Cloudy.	Clear.	...	...	...	300,000
" 22	68	71	71	72	68	72	N.W.	Gale.	N.E.	Strong.	N.E	Strong.	Clear.	Clear.	Clear.	Cloudy.	9	9	195,000	200,000
" 23	60	67	65	68	66	69	N.E.	Strong.	N E.	Strong.	S E	Light.	Clear.	Clear.	Clear.	Clear.	22	22	475,000	100,000
" 24	66	64	68	66	65	68	S.W.	Light.	S.W.	Strong.	S.W.	Strong	Clear.	Clear.	Clear.	Clear.	27	27	590,000	150,000
" 25	60	67	72	69	69	72	W.	Light.	S W.	Strong.	N.W.	Strong.	Cloudy.	Clear.	Cloudy.	Clear.	30	30	660,000	100,000
" 26	66	68	70	69	70	70	N.E.	Strong.	N.E.	Strong	N	Light.	Clear.	Cloudy.	Cloudy.	Clear.	30	30	665,000	150,000
" 27	60	68	66	66	67	67	E.	Light.	S	Strong.	S.	Light.	Cloudy.	Cloudy.	Cloudy.	Clear.	36	36	795,000	100,000
" 28	66	66	74	69	70	70	N.	Strong.	N.E.	Light.	S.	Light.	Clear.	Clear.	Clear.	Clear.	25	25	550,000	425,000
" 29	60	66	74	71	74	71	W.	Light	S.W.	Light.	S.W.	Light.	Clear.	Clear.	Cloudy.	Clear.	25	25	545,000	450,000
" 30	69	68	82	72	83	73	S.	Very Light	S.W.	Light.	S.W.	Light	Cloudy.	Clear.	Clear.	Clear.	27	27	600,000	950,000
" 31	73	71	80	75	90	75	S.	Light.	S.	Light.	S.W.	Very Light	Clear.	Clear.	Clear.	Clear.	15	15	330,000	900,000
June 1	75	74	86	77	93	82	S.W.	Very Light	S W.	Very Light	S.W.	Very Light	Clear	Clear.	Clear	Clear.	17	17	385,000	950,000
" 2	82	76	88	79	86	81	W.	Very Light	S.W.	Very Light	S.	Very Light	Clear.	Clear.	Cloudy.	Clear.	2	2	45,000	725,000
" 3	80	77	74	77	76	78	N.W.	Very Light	S.W.	Very Light	S.	Very Light	Cloudy.	Cloudy.	Cloudy.	Clear.	17	17	300,000	325,000
" 4	66	76	68	76	78	78	W.	Very Light	W.	Very Light	W.	Very Light	Slig'y "	Clear.	Clear	Clear.	30	30	665,000	150,000
" 5	75	74	82	78	74	77	S.W.	Very Light	S.W.	Very Light	N.	Strong.	Clear.	Clear.	Cloudy.	Clear.	15	15	360,000	
" 6	79	70	80	78	74	78	N.W.	Very Light	N.W.	Very Light	N.W.	Strong.	Clear.	Clear.	Cloudy.	Clear.	10	10	225,000	100,000
" 7	58	69	64	69	08	74	N.W.	Strong.	N.	Light.	N.W.	Light.	Clear.	Clear.	Clear.	Clear.	20	20	410,000	325,000
" 8	74	72	78	73	80	76	N.	Very Light	N.W.	Very Light	S.	Very Light	Clear.	Clear.	Clear.	Clear.	11	11	255,000	300,000
" 9	75	73	76	74	85	78	N.E.	Very Light	S.	Very Light	S.	Very Light	Clear.	Clear.	Clear.	Clear.	6	6	115,000	275,000
" 10	70	74	82	78	79	77	S.W.	Very Light	S.	Fair.	S.	Fair.	Clear.	Clear.	Clear.	Clear.	...	...	...	350,000
" 11	74	75	85	79	74	77	S.W.	Fair.	S.W.	Fair.	S.W.	Strong.	Clear.	Clear.	Clear.	Clear.	10	10	220,000	325,000
" 12	70	75	78	78	78	79	S.W.	Light.	S E.	Light.	S.W.	Light	Clear.	Clear.	Clear.	Clear.	14	14	310,000	200,000
" 13	73	76	77	78	74	76	N.W.	Strong.	N.	Strong.	N.W.	Strong.	Clear.	Clear.	Clear.	Clear.	...	...	...	100,000
" 14	09	75	78	78	....	....	N.	Strong.	S.	Fair							...	...	...	250,000
																	503	503	11,015,000	9,515,000

REMARKS.—Sent to Havre de Grace by Quinn 100,000; sent to Havre de Grace for Kumlein 50,000; station moved to Havre de Grace with 400,000 eggs on hand. Total 550,000.

RECORD OF SHAD HATCHING OPERATIONS *conducted at Old Bay Fishery, near Ha*
United States and Maryland F

Date.	Temperature of									Wind.					
	6 A. M.			12 M			6 P. M.			6 A. M.		12 M.		6 P. M.	
	Air.	Surface Water.	Bottom.	Air.	Surface Water.	Bottom.	Air.	Surface Water.	Bottom.	Direction.	Intensity.	Direction.	Intensity.	Direction.	Intensity.
May 30........	..	..	..	..	..	..	82	79	79	....	....	....	....	S. W.	Gentl
May 31........	75	79	78	82	79	79	84	80	80	S. W.	Gentle.	S. W.	Gentle.	N. W.	Gentl
June 1........*	80	80	80	85	81	81	87	81	81	S. W.	Gentle.	S.	Gentle.	S.	Gentl
June 2.........	71	80	80	88	81	81	86	82	82	N. E.	Gentle.	S. E.	Calm.	S. W.	High.
June 3........†	74	80	81	74	80	80	71	80	80	Shifting	High.	Shifting	High.	Shifting	High.
June 4........‡	62	79	79	76	79	79	78	79	79	W.	Strong.	W.	Strong.	S. W.	Light
June 5........§	64	76	76	81	79	78	82	80	79	S. W.	Light.	S. W.	Light.	S. W.	Light
June 6.........	69	78	78	82	80	80	72	78	78	N. W.	Light.	N. W.	Light.	N. W.	Light
June 7........‖	58	68	68	71	74	74	70	76	76	N. W.	Light.	N. W.	Light.	N. W.	Light
June 8 ....¶	60	74	74	74	75	75	82	78	78	S.	Light.	S. E.	Light.	W.	Light
June 9.......**	68	72	72	88	76	76	86	79	79	S.	Light.	S.	Light.	S.	Light
June 10.......††	74	76	76	85	77	77	86	80	80	S.	Light.	S.	Light.	S.	Light
June 11......‡‡	76	76	76	88	79	79	82	79	79	S.	Light.	S.	Light.	S.	Light
June 12........	..	..	..	..	..	..	..	..	..	....	.....	....	....	....	.....
June 13........	..	..	..	..	..	..	..	..	..	....	....	....	....	....	.....
....	..	..	..	..	..	..	..	..	..	....	....	....	....	....	.....

*One boat getting 12 female and no male, which accounts for proportion of eggs to fish spawne
†Proportion of eggs to ripe fish caused by males being found by one boat and females in others
‡Most of eggs badly impregnated in about 90,000 thought to be good.
§Female fish found in one boat and only one male to impregnate eggs.
‖Eggs badly impregnated.

Grace, Md., on the Machinery Barge No. 2, from May 30, 1879, *to June* 13, 1879, *on account of mmissions, by John S. Saunders.*

Condition of				State of Tide.			Total Fish Overhauled.	Ripe Fish.		Eggs Obtained.	Lost.	Fish Hatched.
Sky.			Water.					Males.	Females.			
A. M.	12 M.	6 P. M.		6 A.M.	12 M.	6 P.M.						
......	....	Clear.	Clear.	......	......	......	393	8	6	120,000	20,000	....
lear.	Stormy.	Clear.	Clear.	Ebb.	Slack.	Flood	923	2	1	25,000	5,000	....
lear.	Clear.	Clear.	Clear.	Flood	Flood	Ebb.	1578	13	15	185,000	50,000	....
lear.	Clear.	O'ercast	Clear.	Flood	Ebb.	Ebb.	Heavy Storm.			No nets out.		120,000
aining	Raining	Raining	Clear.	Flood	Flood	Ebb.	397	8	5	45,000	5,000	....
lear.	Clear.	Clear.	Clear.	Flood	Ebb.	Flood	219	6	6	90,000	15,000	....
lear.	Clear.	Clear.	Clear.	Ebb.	Ebb.	Flood	178	2	7	25,000	3,000	....
lear.	Clear.	O'ercast	Clear.	Ebb.	Flood	Ebb.	177	10	10	215,000	55,000	....
lear.	Clear.	Clear.	Clear.	Ebb.	Flood	Slack.	263	30	18½	380,000	80,000	135,000
lear	Clear.	Clear.	Clear.	Ebb.	Flood	Ebb.	220	11	8	175,000	100,000	....
lear.	Clear.	Clear.	Clear.	Ebb.	Flood	Ebb.	230	16	19½	385,000	115,000	187,000
lear.	Clear.	O'ercast	Clear.	Slack.	Flood	Ebb.	149	8	8	95,000	....	....
lear.	Clear.	Clear.	Clear.	Flood	Slack.	Ebb.	132	5	8	160,000	....	285,000
......	......	....	......	......	......	......	....	....	....	....	....	125,000
......	....	....	......	......	......	......	....	....	....	....	....	175,000
......	....	....	......	......	......	......	....	....	....	....	....	225,000
							4859	119	112	1,900,000	448,000	1,252,000

Badly impregnated and injured by heat.
Scarcity of male fish causing many eggs to be unimpregnated.
Transferred to steamer Lookout June 10.
Moved barge to Havre de Grace. Eggs transferred to steamer Lookout June 13.

RECORD OF SHAD HATCHING OPERATIONS *conducted at Old Bay Fishery, near H[illegible] Grace, Md., on the Machinery Barge No. 2, from May 30, 1879, to June 13, 1879, on account of United States and Maryland [illegible]mmissions, by John S. Saunders.*

Date.	Temperature of — 6 A. M. Air.	6 A. M. Surface Water.	6 A. M. Bottom.	12 M. Air.	12 M. Surface Water.	12 M. Bottom.	6 P. M. Air.	6 P. M. Surface Water.	6 P. M. Bottom.	Wind. — 6 A. M. Direction	6 A. M. Intensity.	12 M. Direction.	12 M. Intensity.	6 P. M. Direction.	6 P. M. Intensity.	Condition of — Sky. 6 A. M.	Sky. 12 M.	Sky. 6 P. M.	Water.	State of Tide. 6 A. M.	12 M.	6 P. M.	Total Fish Overhauled.	Ripe Fish. Males.	Ripe Fish. Females.	Eggs Obtained.	Lost.	Fish Hatched.
May 30	......	......	......	......	......	......	82	79	79	......	......	......	......	S. W.	Gen	......	......	Clear.	Clear.	......	......	......	393	8	6	120,000	20,000	......
May 31	75	79	78	82	79	79	84	80	80	S. W.	Gentle.	S. W.	Gentle.	N. W.	Gen	ear.	Stormy.	Clear.	Clear.	Ebb.	Slack.	Flood	923	2	1	25,000	5,000	......
June 1 *	80	80	80	85	81	81	87	81	81	S. W.	Gentle.	S.	Gentle.	S.	Gen	lear	Clear.	Clear.	Clear.	Flood	Flood	Ebb.	1578	13	15	185,000	50,000	......
June 2	71	80	80	88	81	81	86	82	82	N E	Gentle.	S. E	Calm.	S. W.	High	lear	Clear.	O'ercast	Clear.	Flood	Ebb.	Ebb.	Heavy Storm.			No nets out.		120,000
June 3 †	74	80	81	74	80	80	71	80	80	Shifting	High.	Shifting	High.	Shifting	High	aining	Raining	Raining	Clear.	Flood	Flood	Ebb.	397	8	5	45,000	5,000	......
June 4 ‡	62	79	79	76	79	79	78	79	79	W.	Strong.	W.	Strong.	S. W.	Ligh	lear.	Clear.	Clear.	Clear.	Flood	Ebb.	Flood	219	6	6	90,000	15,000	......
June 5 §	64	76	76	81	79	78	82	80	79	S. W.	Light.	S. W.	Light.	S. W.	Ligh	lear	Clear.	Clear.	Clear.	Ebb.	Ebb	Flood	178	2	7	25,000	3,000	......
June 6	69	78	78	82	80	80	72	78	78	N. W.	Light.	N. W	Light.	N. W.	Ligh	Clear	Clear.	O'ercast	Clear.	Ebb.	Flood	Ebb..	177	10	10	215,000	55,000	......
June 7 ‖	58	68	68	71	74	74	70	76	76	N. W.	Light	N. W.	Light.	N. W.	Ligh	Clear.	Clear.	Clear.	Clear.	Ebb.	Flood	Slack.	263	30	18½	380,000	80,000	135,000
June 8 ¶	60	74	74	74	75	75	82	78	78	S.	Light.	S. E.	Light.	W.	Ligh	lear	Clear	Clear.	Clear.	Ebb.	Flood	Ebb.	220	11	8	175,000	100,000	......
June 9 **	68	72	72	88	76	76	86	79	79	S.	Light.	S.	Light.	S.	Ligh	lear	Clear.	Clear.	Clear.	Ebb.	Flood	Ebb.	230	16	19½	385,000	115,000	187,000
June 10 ††	74	76	76	85	77	77	86	80	80	S.	Light.	S.	Light.	S.	Ligh	lear.	Clear.	O'ercast	Clear.	Slack.	Flood	Ebb.	149	8	8	95,000	......	......
June 11 ‡‡	76	76	76	88	79	79	82	79	79	S.	Light.	S.	Light.	S.	Lig	lear.	Clear.	Clear.	Clear.	Flood	Slack	Ebb.	132	5	8	160,000	......	285,000
June 12	......	......	......	......	......	......	......	......	......	......	......	......	......	......	......	......	......	......	......	......	......	......	......	......	......	......	......	125,000
June 13	......	......	......	......	......	......	......	......	......	......	......	......	......	......	......	......	......	......	......	......	......	......	......	......	......	......	......	175,000
....	......	......	......	......	......	......	......	......	......	......	......	......	......	......	......	......	......	......	......	......	......	......	......	......	......	......	......	225,000
																							4859	119	112	1,900,000	448,000	1,252,000

*One boat getting 12 female and no male, which accounts for proportion of eggs to fish spaw[illegible]
†Proportion of eggs to ripe fish caused by males being found by one boat and females in oth[illegible]
‡Most of eggs badly impregnated in about 90,000 thought to be good.
§Female fish found in one boat and only one male to impregnate eggs.
‖Eggs badly impregnated.
[illegible]adly impregnated and injured by heat.
[illegible]Scarcity of male fish causing many eggs to be unimpregnated.
[illegible]Transferred to steamer Lookout June 10.
[illegible]Moved barge to Havre de Grace. Eggs transferred to steamer Lookout June 13.

A careful examination of these tables will show that much the larger proportion of ripe females was found among those taken by the gill-nets at the close of the season. This percentage may seem small, when we remember that for purposes of reproduction alone these migratory fish ascend the rivers. An explanation, however, of the comparatively insignificant numbers of ripe females taken is offered by the fact that the fish are not considered ripe or useful to the fish culturist until they are in the act of spawning or the eggs ready to run freely from them. A very large number of fish caught bear evidence of being near this state. These facts would seem to indicate that the work of hatching shad successfully and on a larger scale would be greatly facilitated by keeping over for a few days, until they become quite ripe, the fish taken just before they are ready to spawn. This plan has been pursued with several varieties of fish, notably with the salmon, which is taken in the spring of the year by pound nets in Penobscot Bay, and transferred thence to fresh water ponds some miles distant, and retained in these until the fall, by which time the eggs are in a proper state of development. The great difficulty with which we have to contend in this treatment of shad consists in the fact that they are so extremely delicate, their scales being easily knocked off, causing disease and death. We have suggested in a previous report the plan of penning the fish by such methods as are used for keeping white fish on Detroit River. In our first report we gave an account of the manner in which the fishing is conducted in the above-named river, and urged our fishermen to adopt the plan pursued with the white fish. Numbers of shad could be held over and sent to market from time to time. This plan we strongly recommended for the "floating batteries" operated at the "Head of the Bay," as enclosures for keeping the fish could be most successfully used in connection with these batteries. Should we succeed in inducing one of the battery owners at Havre de Grace to provide this attachment, we are sure it would enable us to secure a much larger number of spawning fish each year.

The following table shows that deposits of this fish have been made in almost every stream of the Eastern Shore, and in the principal streams of the Western Shore. The distribution to the Eastern Shore was under the personal direction and supervision of Col. Thomas Hughlett, one of the Commissioners of Fisheries.

In making this distribution, on the Western Shore we transferred 200,000 to the upper waters of the Potomac, near the Point of Rocks. Each season we have deposited a large number of them in the headwaters of this river, from Piedmont down to the Falls.

These fish will, doubtless, go down to the ocean; and upon returning as adult fish, for the purpose of reproduction, will make strenuous efforts to pass the Great Falls and other obstructions in the Potomac River. If proper artificial means are provided for their ascent, we are confident that, in a few years, shad and other migratory fish will be found in abundance, even as far as the headwaters of this stream. We propose to pursue, during the coming year, the same plan with the herring and rock, should they be hatched out in large numbers.

Two hundred thousand young shad were turned over to the Commissioners of Fisheries of Pennsylvania, and by them placed in the upper waters of the Susquehanna. We hoped, by such means, to induce the fish to ascend that stream and thereby extend their spawning grounds—a result which would not only greatly benefit the people living in the country drained by the upper portions of the river mentioned, but would also increase the number of fish captured by our own citizens in the vicinity of Havre de Grace.

RECORD OF DISTRIBUTION OF SHAD *made from May* 16, 1879, *to June* 14, 1879, *by the Maryland Commission, under direction of the Commissioners.*

Date.	Place Whence Taken.	No. of Fish.		State.	Introduction of Fish.			Transfer in charge of—
		Orignl'y Taken.	Actually Planted.		Place.	Stream.	Tributary of—	
May 16.	Spesutie Narrows.	300,000	300,000	Maryland..	Spesutie Narro's	Susquehanna Riv.	Chesapeake Bay	U.S.&Md.Sd.H Fce.
May 17.	Spesutie Narrows.	140,000	60,000	Maryland..	Cordova Station	Miles Creek......	Chesapeake Bay	Thos. Hughlett, Jr.
May 17.	Spesutie Narrows.	....	80,000	Maryland..	Cordova Station	Wye Mills Creek.	Miles Creek....	Thos. Hughlett, Jr.
May 18.	Spesutie Narrows.	150,000	150,000	Maryland..	Salisbury	Wicomico River..	Chesapeake Bay	Levin Campbell.
May 19.	Spesutie Narrows.	225,000	115,500	Maryland..	Savage.........	Patuxent River...	Chesapeake Bay	J. F. Ellis.
May 19.	Spesutie Narrows.	....	110,000	Maryland..	Laurel.........	Patuxent River...	Chesapeake Bay	J F. Ellis.
May 19.	Spesutie Narrows.	100,000	100,000	Maryland..	Spesutie Narro's	Susquehanna Riv.	Chesapeake Bay	U. S. & Md.
May 21.	Spesutie Narrows.	25,000	25,000	Maryland..	Havre de Grace.	Susquehanna Riv.	Chesapeake Bay	U. S & Md.
May 21	Spesutie Narrows.	100,000	100,000	Maryland..	Spesutie Narro's	Susquehanna Riv.	Chesapeake Bay	U. S. & Md.
May 24.	Spesutie Narrows	80,000	80,000	Maryland..	Federalsburg...	Nanticoke River..	Chesapeake Bay	Thos. Hughlett, Jr.
May 24.	Spesutie Narrows.	150,000	150,000	Maryland..	Spesutie Narro's	Susquehanna Riv.	Chesapeake Bay	U S. & Md
May 26.	Spesutie Narrows.	150,000	100,000	Maryland..	Whaleysville. ..	Pocomoke River..	Chesapeake Bay	Levin Campbell.
May 26.	Spesutie Narrows.	....	50,000	Maryland..	Near Berlin....	St Michael's Riv.	Chesapeake Bay	Levin Campbell.
May 26.	Spesutie Narrows.	150,000	150,000	Maryland..	Spesutie Narro's	Susquehanna Riv.	Chesapeake Bay	U. S & Md.
May 27.	Spesutie Narrows.	100,000	100,000	Maryland..	Spesutie Narro's	Susquehanna Riv.	Chesapeake Bay	U. S. & Md.
May 28.	Spesutie Narrows.	125,000	125,000	Maryland..	Spesutie Narro's	Susquehanna Riv.	Chesapeake Bay	U. S. & Md.
May 29.	Spesutie Narrows.	100,000	100,000	Maryland..	Henderson.....	Choptank River..	Chesapeake Bay	Thos Hughlett, Jr.
May 29.	Spesutie Narrows.	50,000	50,000	Maryland..	Spesutie Narro's	Susquehanna Riv.	Chesapeake Bay	U. S. & Md.
May 30.	Spesutie Narrows.	200,000	140,000	Maryland..	Millington.....	Chester River....	Chesapeake Bay	Levin Campbell.
May 30	Spesutie Narrows.	....	60,000	Maryland..	Centreville.....	Corsica Creek....	Chester River..	Levin Campbell.

RECORD OF DISTRIBUTION OF SHAD *made from May* 16, 1879, *to June* 14, 1879, *by the Maryland Commission, under direction of the Commissioners*—Continued.

Date.	Place Whence Taken.	No. of Fish.		State.	Introduction of Fish.			Transfer in charge of—
		Orignl'y Taken.	Actually Planted.		Place.	Stream.	Tributary of—	
May 30.	Spesutie Narrows.	200,000	200,000	Maryland..	Spesutie Narro's	Susquehanna Riv	Chesapeake Bay	U. S. & Md.
May 30.	Spesutie Narrows.	150,000	150,000	Maryland..	Spesutie Narro's	Susquehanna Riv.	Chesapeake Bay	U. S. & Md.
May 31.	Spesutie Narrows.	200,000	100,000	Maryland..	Middletown....	Sassafras River...	Chesapeake Bay	Thos. Hughlett, Jr.
May 31.	Spesutie Narrows	....	100,000	Maryland..	Middletown....	Bohemia River...	Chesapeake Bay	Thos. Hughlett, Jr.
May 31	Spesutie Narrows	400,000	400,000	Maryland..	Battery Light..	Susquehanna Riv.	Chesapeake Bay	U. S. & Md.
June 1..	Spesutie Narrows.	40,000	40,000	Maryland..	Havre de Grace	Susquehanna Riv.	Chesapeake Bay	U. S. & Md.
June 1..	Spesutie Narrows.	200,000	200,000	Maryland..	Elkton.........	Elk River........	Chesapeake Bay	Thos. Hughlett, Jr.
June 1..	Spesutie Narrows.	300,000	300,000	Maryland..	Spesutie Narro's	Susquehanna Riv.	Chesapeake Bay	U. S. & Md.
June 1..	Spesutie Narrows.	400,000	400,000	Maryland..	Battery Light..	Susquehanna Riv.	Chesapeake Bay	U. S. & Md.
June 2..	Spesutie Narrows.	300,000	300,000	Maryland..	Port Deposit...	Susquehanna Riv.	Chesapeake Bay	U. S. & Md.
June 2..	Spesutie Narrows	200,000	200,000	Maryland..	Spesutie Narro's	Susquehanna Riv.	Chesapeake Bay	U. S. & Md.
June 2..	Old Bay Fishery..	120,000	120,000	Maryland..	Old Bay Fishery	Susquehanna Riv.	Chesapeake Bay	U. S. & Md.
June 3..	Spesutie Narrows.	300,000	150,000	Maryland..	Princess Anne..	Manokin River...	Chesapeake Bay	Thos. Hughlett, Jr.
June 3.*	Spesutie Narrows.	....	125,000	Maryland	Newtown......	Pocomoke River..	Chesapeake Bay	Thos. Hughlett, Jr.
June 3..	Spesutie Narrows.	150,000	150,000	Maryland..	Spesutie Narro's	Susquehanna Riv.	Chesapeake Bay	U. S. & Md.
June 4..	Spesutie Narrows.	175,000	175,000	Maryland..	Cockeysville ...	Gunpowder River.	Chesapeake Bay	Thos. Hughlett, Jr.
June 4..	Spesutie Narrows.	150,000	150,000	Maryland..	Battery Light..	Susquehanna Riv.	Chesapeake Bay	U. S. & Md.
June 6..	Spesutie Narrows.	100,000	100,000	Maryland..	Spesutie Narro's	Susquehanna Riv.	Chesapeake Bay	U. S. & Md.
June 7.†	Old Bay Channel.	85,000	85,000	Maryland..	Old Bay Fishery	Susquehanna Riv.	Chesapeake Bay	U. S. & Md.

* Lost all the fish in one can. † Station No. 2.

RECORD OF DISTRIBUTION OF SHAD *made from May 16, 1879, to June 14, 1879, by the Maryland Commission, under direction of the Commissioners.*

Date.	Place Whence Taken.	No. of Fish.		State.	Introduction of Fish.			Transfer in charge of—
		Orig'nl'y Taken.	Actually Planted.		Place.	Stream.	Tributary of—	
May 16.	Spesutie Narrows.	300,000	300,000	Maryland..	Spesutie Narro's	Susquehanna Riv.	Chesapeake Bay	U.S.&Md.Sd.H Fcc.
May 17.	Spesutie Narrows.	140,000	60,000	Maryland..	Cordova Station	Miles Creek......	Chesapeake Bay	Thos. Hughlett, Jr.
May 17.	Spesutie Narrows.	....	80,000	Maryland..	Cordova Station	Wye Mills Creek.	Miles Creek....	Thos. Hughlett, Jr.
May 18.	Spesutie Narrows.	150,000	150,000	Maryland..	Salisbury	Wicomico River..	Chesapeake Bay	Levin Campbell.
May 19.	Spesutie Narrows	225,000	115,500	Maryland..	Savage.........	Patuxent River...	Chesapeake Bay	J. F. Ellis.
May 19.	Spesutie Narrows.	....	110,000	Maryland..	Laurel.........	Patuxent River...	Chesapeake Bay	J. F. Ellis.
May 19.	Spesutie Narrows.	100,000	100,000	Maryland..	Spesutie Narro's	Susquehanna Riv.	Chesapeake Bay	U. S. & Md.
May 21.	Spesutie Narrows	25,000	25,000	Maryland..	Havre de Grace.	Susquehanna Riv.	Chesapeake Bay	U. S. & Md.
May 21	Spesutie Narrows.	100,000	100,000	Maryland..	Spesutie Narro's	Susquehanna Riv.	Chesapeake Bay	U. S. & Md.
May 24.	Spesutie Narrows	80,000	80,000	Maryland..	Federalsburg...	Nanticoke River..	Chesapeake Bay	Thos. Hughlett, Jr.
May 24.	Spesutie Narrows.	150,000	150,000	Maryland..	Spesutie Narro's	Susquehanna Riv.	Chesapeake Bay	U S. & Md
May 26.	Spesutie Narrows	150,000	100,000	Maryland..	Whaleysville...	Pocomoke River..	Chesapeake Bay	Levin Campbell.
May 26.	Spesutie Narrows.	....	50,000	Maryland..	Near Berlin....	St Michael's Riv.	Chesapeake Bay	Levin Campbell.
May 26.	Spesutie Narrows	150 000	150,000	Maryland..	Spesutie Narro's	Susquehanna Riv.	Chesapeake Bay	U S & Md.
May 27.	Spesutie Narrows.	100,000	100,000	Maryland..	Spesutie Narro's	Susquehanna Riv.	Chesapeake Bay	U. S. & Md.
May 28.	Spesutie Narrows.	125,000	125,000	Maryland..	Spesutie Narro's	Susquehanna Riv.	Chesapeake Bay	U. S. & Md.
May 29.	Spesutie Narrows.	100,000	100,000	Maryland..	Henderson.....	Choptank River..	Chesapeake Bay	Thos Hughlett, Jr.
May 29	Spesutie Narrows.	50,000	50,000	Maryland..	Spesutie Narro's	Susquehanna Riv.	Chesapeake Bay	U. S. & Md.
May 30	Spesutie Narrows	200,000	140,000	Maryland..	Millington.....	Chester River....	Chesapeake Bay	Levin Campbell.
May 30	Spesutie Narrows.	....	60,000	Maryland..	Centreville.....	Corsica Creek....	Chester River..	Levin Campbell.

RECORD OF DISTRIBUTION OF SHAD *made from May 16, 1879, to June 14, 1879, by the Maryland Commission, under direction of the Commissioners*—Continued.

Date.	Place Whence Taken.	No. of Fish.		State.	Introduction of Fish.			Transfer in charge of—
		Orig'nl'y Taken.	Actually Planted.		Place.	Stream.	Tributary of—	
May 30.	Spesutie Narrows.	200,000	200,000	Maryland..	Spesutie Narro's	Susquehanna Riv	Chesapeake Bay	U. S. & Md.
May 30.	Spesutie Narrows.	150,000	150,000	Maryland..	Spesutie Narro's	Susquehanna Riv.	Chesapeake Bay	U. S. & Md.
May 31.	Spesutie Narrows	200,000	100,000	Maryland..	Middletown....	Sassafras River...	Chesapeake Bay	Thos. Hughlett, Jr.
May 31.	Spesutie Narrows	....	100,000	Maryland..	Middletown ...	Bohemia River...	Chesapeake Bay	Thos. Hughlett, Jr.
May 31	Spesutie Narrows	400,000	400,000	Maryland..	Battery Light..	Susquehanna Riv.	Chesapeake Bay	U. S. & Md.
June 1..	Spesutie Narrows.	40,000	40,000	Maryland..	Havre de Grace	Susquehanna Riv.	Chesapeake Bay	U S. & Md.
June 1..	Spesutie Narrows.	200,000	200,000	Maryland..	Elkton.........	Elk River........	Chesapeake Bay	Thos. Hughlett, Jr.
June 1..	Spesutie Narrows.	300,000	300,000	Maryland..	Spesutie Narro's	Susquehanna Riv.	Chesapeake Bay	U. S. & Md.
June 1..	Spesutie Narrows.	400,000	400,000	Maryland..	Battery Light..	Susquehanna Riv.	Chesapeake Bay	U. S. & Md.
June 2..	Spesutie Narrows.	300,000	300,000	Maryland..	Port Deposit...	Susquehanna Riv.	Chesapeake Bay	U. S. & Md.
June 2..	Spesutie Narrows	200 000	200,000	Maryland..	Spesutie Narro's	Susquehanna Riv.	Chesapeake Bay	U. S. & Md.
June 2..	Old Bay Fishery..	120,000	120,000	Maryland..	Old Bay Fishery	Susquehanna Riv.	Chesapeake Bay	U. S. & Md.
June 3..	Spesutie Narrows.	300,000	150,000	Maryland..	Princess Anne..	Manokin River...	Chesapeake Bay	Thos Hughlett, Jr.
June 3.*	Spesutie Narrows.	....	125,000	Maryland	Newtown......	Pocomoke River..	Chesapeake Bay	Thos. Hughlett, Jr.
June 3..	Spesutie Narrows.	150,000	150,000	Maryland..	Spesutie Narro's	Susquehanna Riv.	Chesapeake Bay	U. S. & Md.
June 4.	Spesutie Narrows.	175,000	175,000	Maryland..	Cockeysville ...	Gunpowder River.	Chesapeake Bay	Thos. Hughlett, Jr.
June 4..	Spesutie Narrows.	150,000	150,000	Maryland..	Battery Light..	Susquehanna Riv.	Chesapeake Bay	U. S. & Md.
June 6..	Spesutie Narrows.	100,000	100,000	Maryland..	Spesutie Narro's	Susquehanna Riv.	Chesapeake Bay	U. S & Md.
June 7.†	Old Bay Channel.	85,000	85,000	Maryland..	Old Bay Fishery	Susquehanna Riv.	Chesapeake Bay	U. S. & Md.

* Lost all the fish in one can.

† Station No. 2.

RECORD OF DISTRIBUTION OF SHAD *made from May* 16, 1879, *to June* 14, 1879, *by the Maryland Commission, under direction of the Commissioners*—Continued.

Date.	Place Whence Taken.	No. of Fish. Orign'ly Taken.	No. of Fish. Actually Planted.	State.	Introduction of Fish. Place.	Introduction of Fish. Stream.	Introduction of Fish. Tributary of—	Transfer in charge of—
June 8.*	Old Bay Channel.	175,000	175,000					
June 8..	Spesutie Narrows.	100,000	100,000	Maryland..	Relay Station..	Patapsco River...	Chesapeake Bay	Wm. Hamlen.
June 9..	Spesutie Narrows	137,000	137,000	Maryland..	Spesutie Narro's	Susquehanna Riv.	Chesapeake Bay	U. S. & Md.
June 10.	Spesutie Narrows	200,000	200,000	Maryland..	Old Bay Fishery	Susquehanna Riv.	Chesapeake Bay	U. S. & Md.
June 10†	Old Bay Channel.	125,000	125,000	Maryland..	Point of Rocks	Potomac River...	Chesapeake Bay	J. F. Ellis.
June 10.	Spe utie Narrows	200,000	50,000	Maryland..	Patuxent.......	Patuxent River...	Chesapeake Bay	W. M. Russ.
June 10.	Spesutie Narrows.	....	25,000	Maryland..	Federalsburg...	Nanticoke River..	Chesapeake Bay	Thos. Hughlett, Jr.
June 10.	Spesutie Narrows.	....	25,000	Maryland..	Airy's Station..	Transquaking Riv.	Chesapeake Bay	Thos. Hughlett, Jr.
June 10.	Spesutie Narrows.	....	50,000	Maryland..	Cambridge	Blackwater River.	Chesapeake Bay	Thos. Hughlett, Jr.
June 10.	Spesutie Narrows.	....	50,000	Maryland..	Hillsborough...	Tuckahoe River..	Chesapeake Bay	Thos. Hughlett, Jr.
June 10.	Spesutie Narrows.	150,000	150,000	Maryland..	Henderson.....	Choptank River..	Chesapeake Bay	Thos Hughlett, Jr.
June 11‡	Spesutie Narrows.	125,000	105,000	Maryland..	Battery Light..	Susquehanna Riv.	Chesapeake Bay	U. S & Md.
June 11‖	Spesutie Narrows.	200,000	140,000	Maryland..	R. R. Crossing..	Gunpowder River	Chesapeake Bay	N. Simmons.
June 11.	Spesutie Narrows	160,000	160,000	....	Upper	Waters of the	Susquehanna.	Penna Commission.
June 14.	Spesutie Narrows.	75,000	75,000	Maryland..	Little Falls	Potomac River...	Chesapeake Bay	J. F. Ellis.
June 14.	Spesutie Narrows.	200,000	200,000	Maryland..	Port Deposit...	Susquehanna Riv.	Chesapeake Bay	U. S. & Md.
	Barge No. 1......	400,000	400,000	Maryland..	Havre de Grace.	Susquehanna Riv.	Chesapeake Bay	U S. & Md.
		7,862,000	7,757,000					

* 50,000 from Station No. 2. †50,000 from Station No. 2. ‡Nearly all in one can died.

‖ 60,000 fish lost before leaving Havre de Grace; balance, in good condition, turned over to Mr. Creveling, of Pennsylvania.

RECORD OF DISTRIBUTION OF SHAD *made from May* 16, 1879, *to June* 14, 1879, *by the Maryland Commission, under direction of the Commissioners*—Continued.

Date.	Place Whence Taken.	No. of Fish.		State.	Introduction of Fish.			Transfer in charge of—
		Orign'ly Taken.	Actually Planted.		Place.	Stream.	Tributary of—	
June 8.*	Old Bay Channel.	175,000	175,000					
June 8..	Spesutie Narrows.	100,000	100,000	Maryland..	Relay Station..	Patapsco River...	Chesapeake Bay	Wm. Hamlen.
June 9..	Spesutie Narrows.	137,000	137,000	Maryland..	Spesutie Narro's	Susquehanna Riv.	Chesapeake Bay	U. S. & Md.
June 10.	Spesutie Narrows	200,000	200,000	Maryland..	Old Bay Fishery	Susquehanna Riv.	Chesapeake Bay	U. S. & Md.
June 10†	Old Bay Channel.	125,000	125,000	Maryland..	Point of Rocks.	Potomac River...	Chesapeake Bay	J. F. Ellis.
June 10.	Spe-utie Narrows	200,000	50,000	Maryland..	Patuxent.......	Patuxent River...	Chesapeake Bay	W. M. Russ.
June 10.	Spesutie Narrows.	....	25,000	Maryland..	Federalsburg...	Nanticoke River..	Chesapeake Bay	Thos. Hughlett, Jr.
June 10.	Spesutie Narrows.	....	25,000	Maryland..	Airy's Station..	Transquaking Riv.	Chesapeake Bay	Thos. Hughlett, Jr.
June 10.	Spesutie Narrows.	....	50,000	Maryland..	Cambridge	Blackwater River.	Chesapeake Bay	Thos. Hughlett, Jr.
June 10.	Spesutie Narrows.	....	50,000	Maryland..	Hillsborough...	Tuckahoe River..	Chesapeake Bay	Thos. Hughlett, Jr.
June 10.	Spesutie Narrows.	150,000	150,000	Maryland..	Henderson.....	Choptank River..	Chesapeake Bay	Thos Hughlett, Jr.
June 11‡	Spesutie Narrows.	125,000	105,000	Maryland..	Battery Light..	Susquehanna Riv.	Chesapeake Bay	U. S. & Md.
June 11‖	Spesutie Narrows.	200,000	140,000	Maryland..	R. R. Crossing..	Gunpowder River.	Chesapeake Bay	N. Simmons.
June 11.	Spesutie Narrows.	160,000	160,000	....	Upper	Waters of the	Susquehanna.	Penna Commission.
June 14.	Spesutie Narrows.	75,000	75,000	Maryland..	Little Falls	Potomac River...	Chesapeake Bay	J. F. Ellis.
June 14.	Spesutie Narrows.	200,000	200,000	Maryland..	Port Deposit...	Susquehanna Riv.	Chesapeake Bay	U. S. & Md.
	Barge No. 1......	400,000	400,000	Maryland..	Havre de Grace.	Susquehanna Riv.	Chesapeake Bay	U S. & Md.
		7,862,000	7,757,000					

* 50,000 from Station No. 2. †50,000 from Station No. 2. ‡Nearly all in one can died.

‖ 60,000 fish lost before leaving Havre de Grace; balance, in good condition, turned over to Mr. Creveling, of Pennsylvania.

Brook Trout—(*Salvelinus fontinalis*).

In the Fall we contracted with the proprietors of the Ludlow Trout farm in Pennsylvania for one hundred thousand eggs of the brook trout. These were received on the thirtieth of November, 1878. Shortly after they were placed in the hatching-house in Druid Hill Park the eggs commenced to hatch. The fish were sufficiently advanced to be ready for issue by the nineteenth of February, when, in accordance with the usual custom, the distribution commenced. The accompanying tables show the details.

As there was an unusual mortality with the eggs, and with the young fish soon after they left the shell, only forty-seven thousand were delivered to the applicants. Quite a number of fish were kept, as usual, for experimental purposes. It was very important that we should thoroughly test, the capacities of the limited ponds adjacent to the hatching-house for keeping this variety of fish during the summer months, as it is necessary that we should raise a sufficient number of fish to furnish breeders enough to produce eggs adequate to supply the increasing demands for trout. The necessity for purchasing eggs from other establishments has been a considerable drain on the resources of the Commission.

If we can keep in a healthy condition a few hundred adult breeding fish in our own ponds, we could, without any additional expense, secure a large number of eggs for distribution each season. As a large proportion of the water used to supply the trout-ponds in Druid Hill Park is derived directly from the high service reservoir, it is liable to considerable elevation of temperature during the hot summer months, and this heat has been quite disastrous to our efforts hitherto.

If we cannot secure sufficient quantity of water at low temperature to enable us safely to keep the fish of this family in the ponds at Druid Hill Park, it will be necessary for us to secure another site where we can control an ample supply of colder water. During the winter months the water is all that can be desired, and we have been most successful at the hatching-house in perfecting the eggs and caring for the young

fish up to the time when it becomes necessary to transfer them to the waters for which they are intended. While hatching the eggs of the California salmon in hastily prepared apparatus in the headwaters of the Potomac, we secured a number of adult trout which have been placed in the ponds of Druid Hill Park. We hope to be more successful with these. Mr. Alexander Kent, in 1873, captured in the same locality a large number of trout, and successfully transferred them to ponds which he had prepared for their reception in Green Spring Valley. They soon became completely domesticated, and for some time Mr. Kent was quite successful in their propagation. Although this year's distribution was very much smaller than that of the previous years, yet many localities were reached and quite a number of applications were filled, which could not be met in the distribution of the year previous. As in several localities the introduction of brook trout is quite a doubtful experiment, we have decided to await the results of these experiments before making further expenditures.

Land-locked Salmon—(*Salmo salar sebago.*)

Our limited experiments in preceding years have demonstrated the capacity of the land-locked salmon to live in warmer waters than can be endured by the other varieties of the salmon family. As the land-locked salmon grow more rapidly and attain under ordinary circumstances a greater size than the brook trout, and as our experiments indicate that they are a hardier fish we have determined to devote more attention to their introduction. During the year we secured from the eggs presented to the commission by the United States commissioner twenty-six thousand five hundred, which were distributed as will appear in the accompanying table:

RECORD OF DISTRIBUTION OF LAND LOCKED SALMON *made from May 22d*, 1879, *to September* 13*th*, 1879, *by Maryland Commission, under direction of the Commissioners.*

Date of Transfer.	Place whence taken.	No. of Fish.		Introduction of Fish.			Transfer in charge of, or to whom given.
		Orignl'y Taken	Actually Planted.	Place.	Stream	Tributary of—	
May 22.	Druid Hill Hatching House.	750	750	Baltimore, Md.	Stream.	Beaver Dam Cr'k.	J. R. Mordecai.
" 30.		1,000	1,000	Cecil county.	"	Susquehanna R.	Thomas Grubb.
June 6.		500	500	Baltimore county.	Pond	Charles Run	J. M. Pearce.
" 7.		8,000	8,000	Druid Hill Park.	Druid Hill Lake.	Water Works.	Frank Behler.
" 9		2,000	2,000	" "	" "	"	"
" 10.		2,000	2,000	" "	" "	"	"
" 12.		1,000	1,000	Westminster	Pond.	Little Pipe Creek.	H. T. Weaver.
" 12.		2,000	2,000	Westminster	Cobb's Branch.	Water Works.	W. A. Cunningham.
" 16.		1,000	1,000	Hampton, Baltimore county.	Pond	Gunpowder River.	John Ridgeley.
" 20.		500	500	Charles Street avenue.	Lake	Stony Run.	J. A. Edmonson.
" 23.		500	500	Union Bridge	Pond	Big Pipe Creek.	Pemberton Wood.
" 23.		1,000	1,000	"	"	" "	J. S. Koontz.
July 3.		500	500	Reisterstown, Baltimore co.	Lake	Patapsco Falls	J. V. Brown.
Aug. 1.		1,000	1,000	Druid Hill Park.	Druid Hill Lake.	Water Works.	Frank Behler.
" 5.	"	1,500	1,500	Burnsides, Baltimore county.	Green Spring Run.	Jones' Falls	S. M. Shoemaker.
" 9.	"	1,000	1,000	Baltimore.	Lake	"	M. A. Leimkubler.
Sept. 13.	"	250	250	Easton, Talbot county.	Pond	Miles Creek.	J. T. Bartlett.
" 13.	"	250	250	" "	"	"	Jas. Tarbutton.
" 13.	"	500	500	" "	"	"	W. Collins.
" 13.	"	250	250	" "	"	"	W. P. Wright.
" 18.	"	500	500	Druid Hill Park.	Druid Hill Lake.	Water Works.	Frank Behler.
" 18.	"	500	500	" "	" "	"	Frank Behler.
		26,500	26,500				

RECORD OF DISTRIBUTION OF BROOK TROUT *made from February 19th*, 1879, *to May 30th*, 1879, *by the Maryland Commission, under direction of the Commissioners.*

Date of Transfer.	Place whence taken.	No. of Fish.		Introduction of Fish.			Transfer in charge of, or to whom given.
		Orignl'y Taken.	Actually Planted	Place.	Stream.	Tributary of—	
Feb. 19.	Druid H. Hatch'g House.	1,000	1,000	Union Bridge, Md	Little Pipe Creek	Monocacy River	Pemberton Wood.
" 28.		3,000	3,000		N. Branch Patuxent.	Patuxent River	A. B. Davis.
Mar. 7.		1,000	1,000	Carrolton, Md	Spring Run	Gunpowder	Henry Taylor.
" 19.		2,500	2,500	Baltimore county	"	Beaver Dam Cr'k.	George Brown.
" 21.		500	500				John R. Long.
" 22.		500	500	Carrolton, Md	Beaver Run	Patapsco	J. W. Wilderson.
" 22.		2,000	2,000	"	"	"	W. S. Weaver.
" 22.		2,000	2,000	"	"	"	Wm. Arbaugh.
" 25.		1,000	1,000	Amendale, Prince George co.	Spring Run	Patuxent	Admiral Ammen.
" 26.		900	900	Headwaters Wye River	Eastern Bay	Chesapeake Bay	Thomas Hughlett.
" 26		1,000	1,000	Skipton	Hardcastle's Stream.	Wye River	" "
" 26.		800	800	"	Tavernus Branch.	"	" "
" 26.		700	700	"	Tanyards Branch.	"	" "
" 26.		600	600	Long Woods	Three Bridges	"	" "
" 26.		1,500	1,500	Cordosa	Hennington's Brnch	Choptank	" "
" 26.		2,000	2,000	Woodstack Branch	Easton	"	" "
" 26.		500	500	Trappe	Wright's Pond	"	" "
" 26.		500	500	"	Collins' Pond	"	" "
" 26.		500	500	"	Bartlett's Pond	"	" "
" 26		1,000	1,000	Balkun's P. O	Long Green Branch.	Gunpowder.	J. S. Gittings.
" 27.		7,000	7,000	Issued by Commissioner Hughlett.			

RECORD OF DISTRIBUTION OF BROOK TROUT *made from February 19th*, 1879, *to May 30th*, 1879, *by the Maryland Commission, under direction of the Commissioners*—Continued.

Date of Transfer.	Place whence taken.	No. of Fish.		Introduction of Fish.			Transfer in charge of, or to whom given.
		Orignl'y Taken.	Actually Planted.	Place.	Stream.	Tributary of—	
Mar 27.	....	1,000	1,000	Carroll county	Pond	Meadow Branch..	Jacob Eckard.
" 27.	....	1,000	1,000	St. Dennis, Baltimore county.	....	Patapsco	John Donaldson.
" 27.	....	1,000	1,000	Chestertown, Kent county...	Langsford Bay.....	Chester River....	J. Ringold.
" 28.	....	1,000	1,000	Woodberry, Md...........	Bee Tree..........	Jones' Falls......	Dr. D. S. Williams.
" 28.	....	1,000	1,000	Chestertown, Kent county...	Radcliff's Pond.....	Chester River....	J. H. Sappington.
" 29.	....	1,000	1,000	Liberty, Frederick county...	Israel Creek........	Potomac.........	J. F. Eyler.
" 29.	....	1,000	1,000	Denning's, Carroll county...	Sam's Creek........	Monocacy	P. Bennett.
" 31.	....	1,000	1,000	Timonium, Baltimore county	Pot Spring Branch .	Gunpowder	C. C. Poultney.
April 1	....	1,000	1,000	Catoctin Furnace..........	Fishing Creek......	Catoctin River...	W. H. Ward.
" 7.	....	1,000	1,000	Green Spring Valley........	Western Run.......	Jones' Falls......	S. S Stump.
" 22.	....	1,000	1,000	Timonium, Baltimore county	Jones' Falls........	Gunpowder	J. F. C. Talbot.
" 26.	....	1,000	1,000	....	Israel Creek........	Potomac.........	E. B. Nicewaner.
" 26.	....	1,500	1,500	McDonogh School..........	Horse-Head Run...	Gwynn's Falls....	S. H. Tagart.
May 1.	....	1,000	1,000	....	Small Run.........	Patuxent.........	D. S. Lyon.
" 3.	....	500	500	....	Pond.	....	R. Jones.
" 22.	....	1,000	1,000	Green Spring Valley........	Beaver Dam Creek .	Jones' Falls......	J. R. Mordecai.
" 30.	....	500	500	Frederick county..........	Pond	....	W. C. Young.
		47,000	47,000				

I.

California Salmon—(*Salmo guinnat.*)

We have in our previous reports given the reasons which induced us to devote ourselves assiduously to the establishment of this most valuable fish in Maryland waters.

The distribution of fish obtained from the eggs presented by the U. S. Commissioner in the fall of 1878 was not completed on the first of January, and therefore not detailed in our report of that date. In accordance with our understanding with the U. S. Commissioner, we sent some of the salmon hatched for him at the Druid Hill Hatching-House to southern waters. These transfers were in charge of the men in the employ of the Maryland Commission, but the expenses were paid by the U. S. Commission. The details of this distribution will be found in the subsequent table.

The remaining young fish, amounting in all to 62,236, were disposed of in the early portion of the year. These were considerably larger than those usually sent out from the hatching-house, as they had been fed for a considerable time. In this manner, by depositing the fish not only as soon as the umbilical sac is absorbed, but by keeping and feeding them some time before they are deposited in the stream for which they are intended, and after they have attained considerable size, we have endeavored to insure the survival of a sufficient number to make their presence felt when they returned as adults from the sea.

The total distribution of California salmon in Maryland waters during the year 1879 amounted to 315,236, making an aggregate deposit of 2,532,140 young fish in the rivers of Maryland since the organization of the Commission. Experience has shown that the salmon do not attain their growth or return from the ocean for the purpose of spawning before the fourth or fifth year. We have therefore not looked for any results from these deposits up to this time, but we should commence to receive the benefits of their return in the course of the next year or so. Should these experiments prove successful, this fish, which enters so largely into the productive value of the rivers flowing into the Pacific, will be a most val-

uable acquisition to our fish-food. The fact that this fish is found in waters very much warmer than those inhabited by their cousins in the Atlantic, induced us to devote our energies more particularly to them. But the return of the Penobscot salmon in the Delaware River, and the capture of a large Penobscot salmon near Spesutie Island, has given us more confidence in the adaptability of Maryland waters to the Eastern variety.

Hitherto we have hatched all of the eggs of the salmon family in the hatching-house at Druid Hill Park. When the young fish were sufficiently advanced to warrant their distribution, they were transferred to the upper waters of the streams of the State, and in the distributions we have endeavored to reach points as high up the streams as practicable, where the water was colder and more likely to fill the requirements of the young fish. These transfers were attended with considerable labor and difficulty, and sometimes with some loss of fish. We therefore deemed it of sufficient importance to establish a temporary station at the head waters of the Potomac, where the fish intended for that stream could be hatched and turned loose in the river adjacent to the hatching-station. By this method we would avoid the necessity of moving the fish and endangering their safety. Accordingly, on the arrival of 500,000 eggs issued to the Maryland Commission by the U. S. Commissioner, we transferred 200,000 of them to the upper waters of the Potomac, in Garrett County, where we improvised a temporary hatching-station. The locality selected was on a farm belonging to Judge Dobbin, known as Kitzmiller's farm, on the north branch of the Potomac, several miles above Fort Pendleton. A pool immediately below a fall of about four feet in the river was selected. In this pool were placed a number of floating barges, in which trays containing the eggs were deposited. The water from above the falls was led to these barges by a trough properly protected by wire grating which discharged the water on the top of barges, the latter being provided with wire bottoms so that the water passed through the trays and out at the bottom. The trough and barges were so arranged that they would rise or

fall with the water in the river. In this manner we thoroughly guarded against any disaster from freshets or a sudden fall of the river. An examination of the accompanying table will show how successful the experiment was, and how small the daily losses of eggs. The experiment demonstrated how practical it is to hatch the eggs and care for the fish until the sac is absorbed without the expensive adjunct of an elaborate hatching-house. With the experiences of this season we are convinced that the most effectual means of stocking streams, with fish not easily accessible by rail and wagon, is to pursue methods similar to those above described. It is entirely practicable with an equipment which can readily be carried in a wagon to organize a hatching-station where pure and wholesome water can be found, almost as quickly as a tent can be pitched, and that, too, on a scale sufficient to provide for a half million trout eggs. It will be observed that those fish kept in the warmer waters of Druid Hill Park were hatched and ready for distribution by the twenty-sixth of November, about the time the eggs which were hatching in the upper waters of the Potomac were freed from the shell, showing a retardation of about one month by the employment of the cold mountain water. When the development proceeds slowly, the young fish are more vigorous than those from rapidly hatched eggs. These experiments would indicate that better results would hereafter be obtained by seeking those localities with colder water. All of the fish obtained from the 200,000 eggs transferred to the hatching-station in the north branch of the Potomac were turned loose in the river. The details of the distribution obtained from 300,000 eggs retained at the Druid Hill Hatching-House will be found in the accompanying table.

The table showing the average temperature of air and water at Druid Hill Park for each month during the year, and the summary of the monthly loss and distribution of fish will also be found.

RECORD OF DISTRIBUTION OF CALIFORNIA SALMON *made on January 6th*, 1879, *by the United States Fish Commission, under direction of Maryland Commissioners.*

Date of Transfer.	Obtained from	Place whence taken.	No. of Fish.		Introduction of Fish.			Transfer in charge of, or to whom given.
			Orignl'y Taken.	Actually Planted.	Place.	Stream.	Tributary of—	
Jan'y 6.	U.S.F.C. McLoud River, Cal.	Druid Hill Hatching H.	1,500	1,500	Charlotte, N. C	Catawba River.	Santee	Wm. H. Busch.
" 6.			4,500	4,500	R. R. Crossing	Broad River	"	" "
" 6.			4,500	4,500	Spartansburg C. H	Pacolett	"	" "
" 6			4,500	4,500	Easley, S. C	Saluda River	"	" "
" 6			5,000	5,000	Orangeburg, S. C	Edisto River	Ocean	Wm. Hamlen.
" 6.			5,000	5,000	Biggins Church, S. C	Cooper River	"	" "
			25,000	25,000				

RECORD OF CALIFORNIA SALMON HATCHING OPERATIONS *conducted at* *October* 15, 1879, *to November* 26, 1879, *on account of Maryland*

Date.	Temperature of Air.			Temperature of Surface Water.			Wind. Direction.			Wind. Intensity.		
	6 A. M.	12 M.	6 P. M.	6 A. M.	12 M.	6 P. M.	6 A. M.	12 M.	6 P. M.	6 A. M.	12 M.	6 P. M.
Oct. 15..	....	75	62	....	58	58	....	....	....	....	....	Calm.
Oct. 16..	48	80	64	54	59	60	....	S. W.	S. W.	Calm.	Light.	Light.
Oct. 17..	47	58	63	53	56	53	N. W.	N. W.	N. W.	Light.	Light.	Light.
Oct. 18..	59	59	60	57	59	59	N. W.	N. W.	N. W.	Calm.	Light.	Light.
Oct. 19..	47	48	46	54	53	53	N. E.	N. E.	N. W.	Light.	Light.	Strong.
Oct. 20..	34	61	47	45	47	49	....	N. W.	N. W.	Calm.	Fresh.	Fresh.
Oct. 21..	41	50	49	45	48	47	N. E.	N. E.	N. W.	Light.	Light.	Light.
Oct. 22..	40	55	58	45	48	50	N. W.	N. W.	N. W.	Light.	Light.	Light.
Oct. 23..	54	52	43	51	51	50	N. W.	S. E.	N.	Fresh.	Fresh.	Fresh.
Oct. 24..	35	36	33	43	42	41	N. E.	N.	N.	Fresh.	Strong.	Strong.
Oct. 25..	22	42	36	35	38	39	N. W.	N. W.	N. W.	Light.	Light.	Light.
Oct. 26..	19	45	41	33	36	39	N. W.	N. W.	N. W.	Light.	Light.	Light.
Oct. 27..	32	50	45	35	40	41	N. W.	S. W.	S. W.	Light	Light.	Light.
Oct. 28..	45	46	43	41	42	42	N. W.	N. W.	N. W.	Strong.	Strong.	Strong.
Oct. 29.	39	60	50	40	44	45	N. W.	N W.	N. W.	Strong.	Strong.	Strong.
Oct. 30..	46	55	42	44	43	40	N. W.	N. W.	N. W.	Strong.	Strong	Light.
Oct. 31..	35	44	32	36	42	38	N. W.	N. W.	N. W.	Strong	Strong.	Light.
Nov. 1..	30	36	32	34	35	34	N. W.	N. W.	N. W.	Light.	Strong.	Strong.
Nov. 2..	20	34	35	32	34	35	N. W.	N. W.	S. E.	Light.	Light.	Strong.
Nov. 3..	22	23	22	33	33	33	N. E.	N. E.	N. E.	Strong.	Strong.	Strong.
Nov. 4..	21	25	24	33	33	33	N. W.	N. W.	N. W.	Strong.	Strong.	Strong.
Nov. 5..	13	35	34	32	33	33	N. W.	N. E.	N. E.	Strong.	Strong.	Light.
Nov. 6..	34	35	35	33	33	33	S. W.	S. W.	S. W.	Light.	Light.	Light.
Nov. 7..	35	42	37	33	33	33	N. W.	N. W.	N. W.	Light.	Light.	Light.
Nov. 8..	36	43	42	33	34	34	N. W.	S. W.	S. W.	Light.	Light.	Light.
Nov 9..	47	61	54	37	42	41	....	N. W.	N. W.	Calm.	Light.	Light.
Nov. 10	54	....	....	43	....	....	N. W.	....	....	Light.	....	....
Nov. 18.	From Nov. 10th to Nov. 18th, the number of dead eggs was..........											
Nov. 26.	The total number of dead eggs from Nov. 18th to the 26th, when all were hatche the river, was..........											

The number of eggs were estimated to be 200,000. The weather becoming very cold, their protection, it was deemed advisable to put 50,000 of the eggs, which were about protected places as hatched.

Judge Dobbin's farm, Garrett County, on the North Branch of the Potomac River, from Fish Commission, by Wm. Hamlen and Wm. P. Sauerhoff.

Condition of Sky. 6 A. M.	12 M.	6 P. M.	Number Lost.	REMARKS.
....	....	Clear.	......	Eggs received at 1.30 P. M.
Cloudy.	Clear.	Clear.	760	6040 dead eggs found on unpacking. Rain 2 P. M. Finished laying out the eggs.
Cloudy.	Cloudy.	Cloudy.	5,280	
Cloudy.	Cloudy.	Cloudy.	457	River raised ½ inch.
Cloudy.	Cloudy.	Clear.	320	Rain stopped 1.30 P. M.
Clear.	Clear.	Clear.	314	
Cloudy.	Cloudy.	Cloudy.	298	Rain 7 A. M. Stopped 5.30 P. M.
Clear.	Clear.	Clear.	233	River raised 1½ inches.
Cloudy.	Cloudy.	Cloudy.	288	Rain 6.45 A. M. Stopped 4.30 P. M.
Cloudy.	Cloudy.	Cloudy.	215	River fell 2 inches. Snow 7.30 A. M. Stopped 3.10 P. M.
Clear.	Clear.	Clear.	183	Ice on river.
Clear.	Clear.	Clear.	117	Had to break ice on hatching box so as to get the trays out to pick over the eggs.
Cloudy.	Cloudy.	Cloudy.	194	
Cloudy.	Cloudy.	Cloudy.	181	*Rain* 3.15 A. M. *Hail* 9 A. M. *Snow* 10 A. M. Cleared up 3.20 P. M.
Clear.	Clear.	Clear.	164	
Cloudy.	Clear.	Clear.	149	
Cloudy.	Clear.	Clear.	137	
Clear.	Clear.	Clear.	127	
Clear.	Cloudy.	Cloudy.	......	Eggs not picked on account of ice. Snow 6.15 P. M.
Cloudy.	Cloudy.	Cloudy.	......	Eggs not picked on acc't of ice. Stopped snowing 6.30 P. M.
Cloudy.	Cloudy.	Cloudy.	......	Eggs not picked on acc't of ice. Ice on river 1¼ in. thick.
Cloudy.	Cloudy.	Cloudy.	......	Eggs not picked on acc't of ice. Snow and hail 7.15 P. M.
Cloudy.	Cloudy.	Cloudy.	42	Stopped snowing 3 A. M. Snow and rain from 7 A. M. until 6.30 P. M.
Clear.	Clear.	Clear.	58	River raised 8 in. at 6 A. M., 12 in. at 11 A. M.
Cloudy.	Cloudy.	Cloudy.	546	River fell 4 in. 6 A. M.
Cloudy.	Cloudy.	Cloudy.	161	River fell 3 in. 6 A. M.
Cloudy.	....	....	......	River fell 2 in. 6 A. M.
....	....	....	1,900	
nd the fish turned into				
....	....	....	600	From Nov. 10th to Nov. 18th the number of fish turned out was 76,300.
			12,724	

the location of the tent exposed, and the men not provided with the necessary appliances for hatching, into the stream. The young fish and the balance of the eggs were liberated in

RECORD OF CALIFORNIA SALMON HATCHING OPERATIONS *conducted at Judge Dobbin's farm, Garrett County, on the North Branch of the Potomac River, from October* 15, 1879, *to November* 26, 1879, *on account of Maryland Fish Commission, by Wm. Hamlen and Wm. P. Sauerhoff.*

Date.	Temperature of Air.			Temperature of Surface Water.			Wind. Direction.			Wind. Intensity.			Condition of Sky.			Number Lost.	REMARKS.
	6 A. M.	12 M.	6 P. M.	6 A. M.	12 M.	6 P. M.	6 A. M.	12 M.	6 P. M.	6 A. M.	12 M.	6 P. M.	6 A. M.	12 M.	6 P. M.		
Oct. 15..	....	75	62	....	58	58	....	....	....	....	....	Calm.	...	....	Clear.	......	Eggs received at 1.30 P. M.
Oct. 16..	48	80	64	54	59	60	....	S. W.	S. W.	Calm.	Light.	Light.	Cloudy.	Clear	Clear.	760	6040 dead eggs found on unpacking. Rain 2 P. M. Finished laying out the eggs.
Oct. 17..	47	58	63	53	56	53	N. W.	N. W.	N. W.	Light.	Light.	Light.	Cloudy	Cloudy.	Cloudy.	5,280	
Oct. 18..	59	59	60	57	59	59	N. W.	N. W.	N. W.	Calm.	Light.	Light.	Cloudy.	Cloudy.	Cloudy.	457	River raised ½ inch.
Oct. 19 .	47	48	46	54	53	53	N. E.	N. E.	N. W.	Light.	Light.	Strong.	Cloudy	Cloudy.	Clear.	320	Rain stopped 1.30 P. M.
Oct. 20 .	34	61	47	45	47	49	....	N. W.	N. W.	Calm.	Fresh.	Fresh.	Clear	Clear	Clear.	314	
Oct. 21 .	41	50	49	45	48	47	N. E.	N. E	N. W.	Light.	Light.	Light.	Cloudy.	Cloudy.	Cloudy.	298	Rain 7 A. M. Stopped 5.30 P. M.
Oct. 22 .	40	55	58	45	48	50	N. W.	N. W.	N. W.	Light.	Light.	Light.	Clear	Clear.	Clear.	233	River raised 1¼ inches.
Oct. 23..	54	52	43	51	51	50	N. W.	S. E.	N.	Fresh.	Fresh.	Fresh.	Cloudy.	Cloudy.	Cloudy.	288	Rain 6.45 A. M. Stopped 4.30 P. M.
Oct. 24..	35	36	33	43	42	41	N. E.	N.	N.	Fresh.	Strong.	Strong.	Cloudy	Cloudy.	Cloudy.	215	River fell 2 inches. Snow 7.30 A. M. Stopped 3.10 P. M.
Oct. 25..	22	42	36	35	38	39	N. W.	N. W.	N. W.	Light.	Light.	Light.	Clear	Clear.	Clear.	183	Ice on river.
Oct. 26 .	19	45	41	33	36	39	N. W.	N. W.	N. W.	Light.	Light.	Light.	Clear.	Clear.	Clear.	117	Had to break ice on hatching box so as to get the trays out to pick over the eggs.
Oct. 27..	32	50	45	35	40	41	N. W.	S. W.	S. W.	Light	Light.	Light.	Cloudy.	Cloudy.	Cloudy.	194	
Oct. 28..	45	46	43	41	42	42	N. W.	N. W.	N. W.	Strong.	Strong.	Strong.	Cloudy.	Cloudy.	Cloudy.	181	*Rain* 3.15 A. M. *Hail* 9 A. M. *Snow* 10 A. M. Cleared up 3.20 P. M.
Oct. 29.	39	60	50	46	44	45	N. W.	N. W.	N. W.	Strong.	Strong.	Strong.	Clear.	Clear.	Clear.	164	
Oct. 30..	46	55	42	44	43	40	N. W.	N. W.	N. W	Strong.	Strong	Light	Cloudy	Clear.	Clear.	149	
Oct. 31 .	35	44	32	36	42	38	N. W.	N. W.	N. W.	Strong	Strong.	Light.	Cloudy	Clear.	Clear.	137	
Nov. 1 .	30	36	32	34	35	34	N. W.	N. W.	N. W.	Light.	Strong.	Strong.	Clear	Clear	Clear.	127	
Nov. 2..	20	34	35	32	34	35	N. W.	N. W.	S. E.	Light.	Light	Strong.	Clear.	Cloudy.	Cloudy.	......	Eggs not picked on account of ice. Snow 0.15 P. M.
Nov. 3..	22	23	22	33	33	33	N. E	N. E.	N. E.	Strong.	Strong.	Strong.	Cloudy.	Cloudy.	Cloudy.	......	Eggs not picked on acc't of ice. Stopped snowing 6.30 P. M.
Nov. 4 .	21	25	24	33	33	33	N. W.	N. W.	N. W.	Strong.	Strong.	Strong.	Cloudy	Cloudy.	Cloudy.	......	Eggs not picked on acc't of ice. Ice on river 1½ in. thick.
Nov. 5 .	13	35	34	32	33	33	N. W.	N. E.	N. E.	Strong.	Strong.	Light.	Cloudy.	Cloudy.	Cloudy.	......	Eggs not picked on acc't of ice. Snow and hail 7.15 P. M.
Nov. 6..	34	35	35	33	33	33	S. W.	S. W.	S. W.	Light.	Light.	Light.	Cloudy	Cloudy.	Cloudy.	42	Stopped snowing 3 A. M. Snow and rain from 7 A. M. until 6.30 P. M.
Nov. 7..	35	42	37	33	33	33	N. W.	N. W.	N. W.	Light.	Light.	Light.	Clear	Clear.	Clear.	58	River raised 8 in. at 6 A. M., 12 in. at 11 A. M.
Nov. 8..	36	43	42	33	34	34	N. W.	S. W.	S. W.	Light	Light.	Light.	Cloudy.	Cloudy.	Cloudy.	546	River fell 4 in. 6 A. M.
Nov. 9 .	47	61	54	37	42	4t	....	N. W.	N. W.	Calm.	Light.	Light.	Cloudy	Cloudy.	Cloudy.	161	River fell 3 in. 6 A. M.
Nov. 10	54	....	....	43	....	....	N. W.	....	....	Light.	....	....	Cloudy.	....	....	......	River fell 2 in. 6 A. M.
Nov. 18.	From Nov. 10th to Nov. 18th, the number of dead eggs was..........															1,900	
Nov. 26.	The total number of dead eggs from Nov. 18th to the 26th, when all were hatched and the fish turned into the river, was..........															600	From Nov. 10th to Nov. 18th the number of fish turned out was 76,300.
																12,724	

The number of eggs were estimated to be 200,000. The weather becoming very cold, the location of the tent exposed, and the men not provided with the necessary appliances for their protection, it was deemed advisable to put 50,000 of the eggs, which were about hatching, into the stream. The young fish and the balance of the eggs were liberated in protected places as hatched.

RECORD OF DISTRIBUTION OF CALIFORNIA SALMON *made from February 1st*, 1879, *to December 24th*, 1879, *by the Maryland Commission, under direction of the Commissioners.*

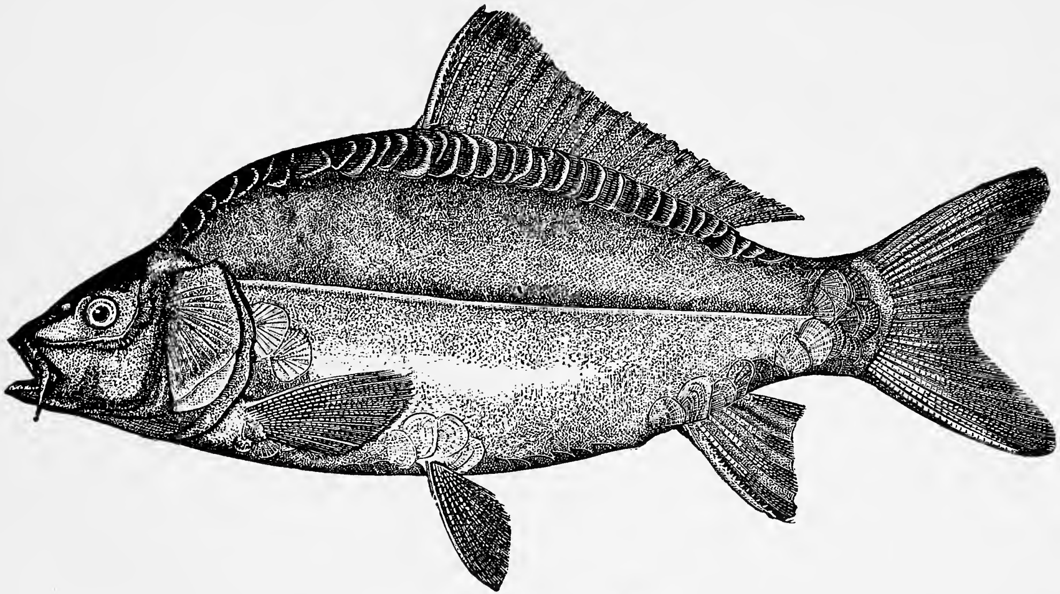
Date of Transfer.	Obtained from	Place whence taken.	No. of Fish. Orign'ly Taken.	No. of Fish. Actually Planted.	Introduction of Fish. Place.	Introduction of Fish. Stream.	Introduction of Fish. Tributary of	Transfer in Charge of, or to Whom Given.
Feb. 1..	U. S. F. Com.	Druid Hill Hatching House.	4,000	4,000	Wilna, Harford Co....	Winter's Run......	Bush River.......	E. Hollingswirth.
Feb. 1..	McCloud River, California.		10,000	10,000	Savage Station.......	Patuxent..........	Patuxent.........	
Feb. 13.			12,000	12,000	Millington............	Chester River.....	Chesapeake Bay..	Thos. Hughlett.
Feb. 21.			8,000	8,000	Henderson, Caroline C.	Choptank River....	Chesapeake Bay..	Thos. Hughlett.
Feb. 24.			7,000	7,000	....	....	....	Wm. Hamlen.
Feb. 26.			3,000	3,000	Cambridge...	Black Water.......	Tangier Sound....	W. H. Jenkins, Jr.
Feb. 26.			3 000	3,000	....	Chickacomico......	Transquaking Riv.	Thos. Hughlett.
Feb. 26.			3,000	3,000	Airey's Sta., Dor. Co..	Transquaking River	Tangier Sound...	Thos. Hughlett.
Feb. 28			12,000	12,000	Hood's Mills & Airey.	Patapsco & Patuxent	Chesapeake Bay..	
June 6..			236	236	....	....	....	
Nov. 26.			15,000	15,000	Parkton, Md.........	Big Gunpowder....	Chesapeake Bay..	Wm. Hamlen.
Nov. 29.			15,000	15,000	Parkton, Md.........	Deer Creek........	Susquehanna Riv.	Wm. Hamlen.
Dec. 4..			20,000	20,000	Laurel, Md...........	Patuxent..........	Chesapeake Bay..	W. H. Jenkins, Jr.
Dec. 4..			20,000	20,000	Savage..............	Middle Patuxent...	Patuxent.........	W. H. Jenkins, Jr.
Dec. 5..	"	"	5,000	5,000	Federalsburg, Dor. Co.	Nanticoke.........	Chesapeake Bay..	Thos Hughlett.
Dec. 5..	"	"	1,000	1,000	Linkwood, Dor. Co...	Transquaking River	Tangier Sound...	Thos. Hughlett.
Dec. 5..	"	"	1,500	1,500	Fleming's Mill, Dor.Co	Chickacomico......	Transquaking Riv.	Thos. Hughlett.
Dec. 5..	"	"	1,500	1,500	Barn's Farm, Dor Co.	Black Water.......	Tangier Sound...	Thos. Hughlett.
Dec. 9..	"	"	6,000	6,000	D. Grue's Mill, Cecil C.	Octarora..........	Chesapeake Bay..	Thos. Hughlett.
Dec. 9..	"	"	5,000	5,000	Henford's M., Cecil C..	East River.........	Chesapeake Bay..	Thos. Hughlett.
Dec. 10.	"	"	6,000	6,000	St. Mark, Cecil Co....	Big Elk River......	Chesapeake Bay..	
Dec. 10.	"	"	5,000	5,000	Millington, Kent Co..	Andover Branch....	Chester River.....	Thos. Hughlett.
Dec. 10.	"	"	15,000	15,000	Harper's Ferry.......	Potomac..........	Chesapeake Bay..	Wm. Hamlen.

RECORD OF DISTRIBUTION OF CALIFORNIA SALMON *made from February 1st*, 1879, *to December 24th*, 1879, *by the Maryland Commission, under direction of the Commissioners*—Continued.

Date of Transfer.	Obtained from	Place whence taken.	No. of Fish.		Introduction of Fish.			Transfer in Charge of, or to Whom Given.
			Orign'ly Taken.	Actually Planted.	Place.	Stream.	Tributary of	
Dec. 11.	McCloud River, California.	Druid Hill Hatching House.	10,000	10,000	Hood's Mills	Patapsco	Chesapeake Bay	Wm. Hamlen.
Dec. 11.			10,000	10,000	Mount Airey	Little Patuxent	Chesapeake Bay	W. H. Jenkins, Jr.
Dec 12.			1,000	1,000	Humpry's Lake, Salis'y	Wicomico Creek	Wicomico River	Thos. Hughlett.
Dec. 12.			4,000	4,000	Salisbury, Md	Wicomico Creek	Wicomico River	Thos. Hughlett.
Dec. 12.			2,000	2,000	Whalesville, Wor. Co.	Pocomoke	Chesapeake Bay	Thos. Hughlett.
Dec. 12.			2,000	2,000	Berlin	Trappe	Choptank River	Thos. Hughlett.
Dec. 12			2,000	2,000	Berlin	Herring Creek	Atlantic Ocean	Thos. Hughlett.
Dec. 13.			10,000	10,000	Hagerstown	Antietam	Potomac	W. H. Jenkins, Jr.
Dec. 13.			10,000	10,000	Hagerstown	Conococheaque	Potomac	Wm. Hamlen.
Dec. 15.			10 000	10,000	W. Md. R. R. Crossing.	Big Pipe Creek	Monocacy	W. H. Jenkins, Jr.
Dec. 15.			10,000	10,000	Mechanicstown	Owen's Creek	Monocacy	Wm. Hamlen.
Dec. 15.			5,000	5,000	Tank Station	North Patapsco	Patapsco	Wm. Hamlen.
Dec. 16.			10,000	10,000	Parkton	Deer Creek	Susquehanna	
Dec. 16.	"	"	1,000	1,000	Sandy Branch	Sassafras	Chesapeake Bay	Thos. Hughlett.
Dec. 16.	"	"	1,000	1.000	Kennedy's Pond, K't C.	Bohemia	Chester River	Thos Hughlett.
Dec. 16.	"	"	6,000	6,000	Carter's Bridge	Great Choptank	Chesapeake Bay	Thos. Hughlett.
Dec. 17.	"	"	10,000	10,000	Cockeysville	Gunpowder	Chesapeake Bay	Wm. Hamlen.
Dec. 18.	"	"	10,000	10,000	Laurel	Patuxent	Chesapeake Bay	Wm. Hamlen.
Dec. 18.	"	"	10,000	10,000	Savage	Middle Patuxent	Patuxent	Frank Behler.
Dec. 23.	"	"	10,000	10,000	Towsontown	Gunpowder	Chesapeake Bay	Wm. Hamlen.
			312,236	312,236				

SUMMARY OF OPERATIONS AT HATCHING HOUSE, DRUID HILL PARK, FOR 1879.

Month.	Average Temperature at Noon of—				California Salmon.			Land Lock Salmon.			Trout.		German Carp.		Penobscot Salmon.	
	Air.	Water.														
		Hydrant.	Spring.	Pond.	Number of Eggs received.	Number of Fish or Eggs lost.	No. distributed.	Number of Eggs received.	Number of Fish or Eggs lost.	No. distributed.	Number of Fish or Eggs lost.	No. distributed.	Number of Fish or Eggs lost.	No. distributed.	Number of Eggs received.	Number of Fish or Eggs lost.
January.....	32.1°	35.18°	54.°	35.13°	......	2,734	29,000	......	......	......	10,269	......	......	......	......	......
February....	32.19	35.16	51.12	35.14	......	761	62,000	......	......	......	43,246	4,000	......	......	......	......
March......	49.5	45.25	49.23	43.23	......	303	......	......	......	......	1,615	34,500	......	......	......	......
April.......	48.1	46.2	48.4	46.13	......	2,354	......	50,000	6,147	......	4,510	5,500	......	......	......	......
May........	68.	63.10	52.11	57.	......	7,249	......	......	4,170	1,750	5,746	3,000	......	......	......	......
June.......	77.12	68.9	56.20	65.26	......	309	236	......	4,168	18,500	40	......	......	......	......	......
July........	82.21	76.13	59.23	75.30	......	14	......	......	8,832	500	24	......	......	......	......	......
August.....	78.12	79.3	61.85	75.21	......	03	......	......	4,366	3,500	01	......	......	......	......	......
September..	69.15	68.27	60.15	69.15	......	......	......	......	216	2,250	......	......	......	......	......	......
October.....	60.21	65.24	59.26	64.22	300,000	33,086	......	......	128	......	......	......	......	......	......	......
November...	48.25	49.23	57.10	50.2	......	4,013	30,000	......	......	......	......	......	......	3,490	......	......
December...	44.10	45.12	53.19	45.01	......	2,616	220,000	......	03	......	......	......	23	2,645	62,500	314
					300,000	53,442	341,236	50,000	28,030	26,500	65,451	47,000	23	6,135	62,500	314



LEATHER CARP.

Carp—(*Cyprinus carpio.*)

In our previous reports we have recorded the successful importation of the German carp. We are now able to present some of the good results therefrom. The fish left in our care by the U. S. Commissioner, as stated in our report, January, 1879, were not placed in the ponds constructed for their reception until late in the spring. It was not thought advisable to draw the water from but one of these ponds in the fall, but from the one drawn we secured about 7,000 young fish for distribution. This fish is especially adapted for small ponds, and is essentially a domestic fish, we were desirous, therefore, to issue them in small numbers and to those wishing to cultivate them in artificial ponds. We deemed it advisable to notify the people of the State, through the principal papers, that upon application at the Druid Hill Hatching House, ten pairs of this fish would be given to every person desiring to stock a pond within the limits of the State. The carp is exceedingly prolific, one of four or five pounds weight producing from 400,000 to 500,000 eggs. One of double the weight mentioned would yield at least 1,500,000 eggs, the number allowed for stocking a pond was, therefore, considered ample, their offspring would soon be numerous enough to stock a considerable lake.

Under this system of distribution seventy-five persons have been supplied up to this time.

The demand for carp not being as great as was anticipated —our people evidently not appreciating its great value as a food-fish, and one eminently qualified for domestic purposes, we arranged with the U. S. Commissioner to supply him with 3500 for present distribution. That number was, accordingly, turned over to his messengers, with the understanding that in return for them the State of Maryland was to receive other fish when the National Carp Ponds at Washington were drawn. As the fish in the Washington ponds are of the *leather carp* variety, which is greatly superior to the *scale-carp*—of which the greater part of those in Druid Hill Park consist—we hope to be able in the spring to distribute the more valuable

species. In order to familiarize our citizens with this fish—which is almost unknown in this country—and enable them to appreciate its full value, we give a detailed description of it, and a cut representing a "*leather-carp.*" We are indebted to the American Agriculturalist, whose editor was furnished with a drawing of one of the *leather carp* from our National Ponds. The electrotype is a reproduction from the illustration given in the January number of that periodical. The carp has been known for centuries in most of the countries of Europe, but has been chiefly cultivated in Germany and Austria. In England and France, although well known, it has not been bred with the care bestowed in the last mentioned countries, where it has attained considerable excellence, and where several varieties of it are to be found, viz: the *scale-carp*, which strongly resembles the original form, imported from Asia centuries ago; the *mirror-carp*, which is almost destitute of scales, and the Leather-carp, which is the most esteemed of the three varieties. It will be observed, see the accompanying engraving, that it is almost entirely devoid of scales, having only *one* row in the dorsal region, and a few near the fins. We have bestowed much care upon the carp, deeming its introduction into Maryland waters of great importance, as it is easily propagated, very prolific, a vegetable feeder, and capable of living in water subject to extreme elevations of temperature. We believe it to be peculiarly adapted to the eastern and southern portions of the State.

The fact of its being a vegetable feeder is an important point in its favor, as such fish can exist and thrive in water in which carnivorous fish would perish for lack of food. It has been noticed in the National Ponds at Washington that the fish feed voraciously and grow fat on the *alga*, commonly called frogs-spittle, which is found, in abundance, in still, or partially stagnant, waters. It also feeds on the worms, and the insects, *larvæ.* which they obtain by rooting in the mud.

It is said that in Europe large numbers are raised on the refuse matter from kitchens, slaughter houses and breweries. We have mentioned the capacity of this fish to survive extreme elevations of temperature, and to thrive in stagnant

water. We should add that it can live in water which at times may become very cold. As soon as the temperature of the water in which it is falls to 39° or 40° (Fahrenheit) it burrows into the mud and soft bottom, where it remains in a semi torpid state until the return of warm weather revives it. During this period, although it does not take food, it is said not to lose flesh. On account of this peculiarity of the carp, the ponds used for rearing it should have muddy bottoms, and should also be furnished with aquatic plants, especially those producing seed, which ripen and fall into the water.

The carp spawns in the spring and summer, sometimes extending its breeding season into the fall months.

The eggs produced attach themselves to the aquatic plants, as above-mentioned, and they hatch in from one to two weeks, according to the temperature of the water. Sudden changes of weather, from warm to cold, often prove fatal to the eggs.

Where the ponds are not amply provided with vegetable growth, and especially seed-bearing plants, this fish may be fed with crumbs of bread, leaves of cabbage, and almost any other kind of vegetable used by man; as well as with rice, corn, and cereals of every description, either whole or ground. Grain is, however, improved by being boiled in plain water.

The eggs—which are a favorite food with other fish—attach themselves as above-mentioned, to twigs and aquatic plants, and are consequently very accessible. For this reason, no other varieties of fish should be allowed in the ponds used for breeding purposes.

The ponds intended by the U. S. Commissioner at Washington to receive a portion of the imported fish (which were temporarily deposited in the ponds of Druid Hill Park) are constructed on the best principles, and have proved very successful. We, therefore, deem it proper to give a description of them, in order that they may serve as models after which ponds may be prepared by persons desirous of engaging in carp culture.

In the accompanying cut, a portion of the largest pond (represented by *I*) is shown. *L* and *K* are smaller ones on

either side of an island which contains the ponds devoted to breeding purposes.

There is nothing special to attract our attention in the construction of these three ponds, except the depressions near the outlet (known as collectors or kettles), into which the fish are gradually drawn when the water is taken from the ponds.

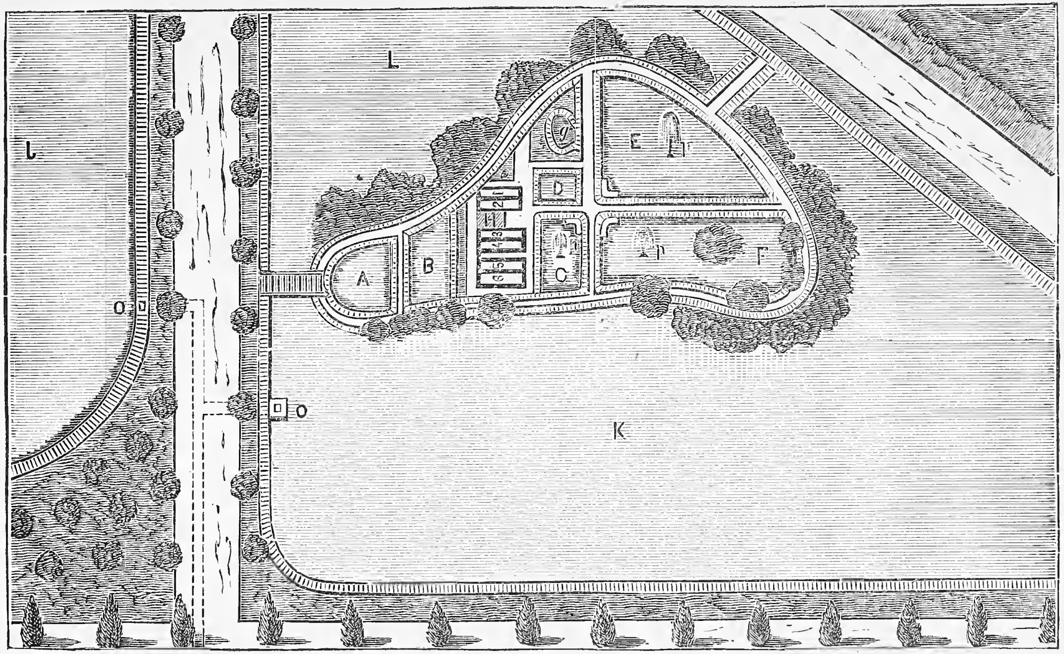
The ponds marked *a*, *b*, *c*, *d*, *e* and *f*, are used exclusively for breeding purposes. The outlet of each of these ponds connects with a drain-pipe which discharges itself into the Potomac River. At the outlet of each there is a kettle, as in those just mentioned, in which the fish are collected.

These ponds are not level, sloping from two inches to to four feet (in depth), the deepest parts being at the collectors. They are well furnished with aquatic plants, and a portion of those marked *a* and *b* are provided with movable partitions constructed in the shallow parts. These separate the more open space of the pond from that of a denser aquatic growth. The spawning fish eagerly seek those portions well provided with grasses, and after depositing their eggs they are allowed to return to the more open space. The partitions are then put in place to prevent their re-visiting the grassy parts and disturbing their eggs.

Figures 1, 2, 3, 4, 5 and 6 represent tanks into which the water can be introduced. These are used for stowing and sorting the fish. No. 7 represents the watch-house occupied by the guard and attendants.

The thorough confidence of Prof. Baird in the ultimate success of the experiment of introducing this fish into American waters is shown by his persistent and repeated efforts to import them. The good results have more than realized our expectations, for the growth and weight of the imported fish and the excellence of their offspring have been greater than under the most favorable circumstances in Europe.

The normal weight attained by the carp, in Europe, when *three years* old (the age of maturity), is said to be from *three* to *four* pounds. Those, however, that were imported into this country now weigh from *nine* to *ten* pounds.



PLAN OF BREEDING PONDS FOR CARP AT WASHINGTON, D. C.

The growth of the young fish in both the Druid Hill and Washington Ponds has been very marked, some of them having attained a length of five to seven inches in one summer. This rapidity of growth may be due to the longer period of warm weather in this latitude, and the consequent extension of the feeding season. If this hypothesis be correct, it is probable that a much greater and more rapid growth will be attained in the waters farther south. Many Eastern States have been supplied by the U. S. Commission. We believe this fish is destined to become, at no distant day, of the greatest importance to both the pisciculturist and agriculturist and, therefore, with a view of acquainting our citizens with its history and qualities we make the following extract from a letter of the U. S. Commissioner on the subject:

Hon. James B. Beck.

Sir: * * * * * * *
* * * * * * * *

I have great faith in the future of this new fish, and am quite well satisfied that within ten years it will constitute a very prominent element in the food animals of the country. Although scarcely known in the United States, and but little more as an article of extended application in England and France, it is in Germany and Austria that it is cultivated in the highest degree, so as to constitute a notable article of market supply. The fish itself is probably of Asiatic origin, and has been domesticated in China for thousands of years. It has, however, been so extensively distributed in Europe as to have become, in a measure, a native fish, occurring in public waters as well as in private enclosures. It is emphatically a farmer's fish, and may safely be claimed to be among fishes what chickens are among birds, and pigs and ruminants among mammals. Its special merit lies in the fact of its sluggishness and the ease with which it is kept in very limited enclosures, its being a vegetable feeder and its general inoffensiveness. Whereas trout and black bass require a supply of animal food for their sustenance and growth, the carp, while not disdaining flies, worms, larvæ, etc., lives on the succulent

roots and leaves of aquatic plants, their seeds fallen into the water and other similar substances, and may be fed very readily upon corn, grain, bread, root crops, raw or boiled, and, indeed, any vegetable refuse whatever. Its rate of growth, too, is somewhat marvelous, and as observed so far in the specimens introduced into the United States, being even more remarkable here than in Europe.

Among the original fish imported by us from Europe, and which are now only about three and a half years old, are some from twenty-five to thirty inches in length, weighing from four to eight or nine pounds.

The three varieties imported by us—the scaly, mirror and leathern carp—are all of first class excellence and characterized by broad backs, as distinguished from the sharp back and more bony characters of the common fish. They occupy a conspicuous place in the German fish markets, and bring the same price as the trout, selling generally for about twenty-five cents per pound. The carp will thrive best in artificial or natural ponds with muddy bottoms and abounding vegetation. In large ponds it may not be necessary to add any special food; but in restricted encloures, as, for instance, in those of a fraction of an acre, they may be fed with the refuse of the kitchen, garden, leaves of cabbage, lettuce, leek, etc., hominy or other substances. Grain of any kind is generally better boiled before being fed to the fish; but this is probably not absolutely necessary. It is a prime necessity that there be no predaceous fish embraced in the same pond with the carp. Of course the larger fish will be measurably secure against the attacks of carnivorous species about the same size, but the eggs and young will become a prey to their associates. The carp spawn in the spring, in May and June, and, indeed, under some circumstances, throughout the entire summer. We have young fish spawned all the way from May until September. They are very prolific, the female varying from 50,000 to 500,000, according to her size. The eggs adhere tenaciously to whatever they touch; for that reason it is very important that the pond should be provided with floating weeds for such attachment. The eggs hatch out

in a few days and the young grow very rapidly. They feed voraciously upon so-called frog-spittle, the green alga scum that is so common in frog ponds. Consequently such waters are especially adapted for carp. Whenever the water becomes chilled down to perhaps 40°, and especially when frozen over at the top, the fish bury themselves in the mud, aggregating in lots from fifty to one hundred, frequently with their tails projecting and constituting what is called in Germany kettles or rolls. It is very important that they should not be disturbed under such circumstances. Of course while hybenating in this way they are not feeding, although they are said not to lose appreciably in weight. In the more southern regions, where the waters do not freeze, they will probably feed throughout the year and make a more rapid growth. So far, no waters have proved too warm for them. As regards the best plants for a carp pond, I may mention the ordinary pond-weeds *pontederia* and *sagittaria*—splatter docks or pond lilies; and, indeed, any of the kinds that grow in the water with leaves floating upon the surface, duck-weed among the number. Those which produce seeds, like the wild rice, are especially desirable, as the fish feed voraciously upon them.

Very truly yours,

SPENCER F. BAIRD.

Dr. Hessel, superintendent of the ponds at Washington, makes the following statement, which shows how well adapted this fish is to fill a need so long felt by those having waters too warm and limited for the propagation of brook trout and other game fishes:

"'The carp is able,' says Dr. Hessel, 'to live in water where other fishes could not possibly exist—for instance, in the pools of bog-meadows or sloughs.' Though it is not to be inferred from this that the best carp ponds should be thus located.

"In Silesia, puddles two or three feet deep, in the villages, are used for raising two year old carp for stocking distant waters. From this resource a single estate realized what would amount to about fifty-five dollars to the acre of pond

surface. In Europe, carp are always taken to market alive, in tanks or barrels, and, if they are not sold, returned to the water alive at the end of the day. They are said to be kept alive in cellars in the winter, wrapped in wet moss and fed upon bread soaked in milk. Dr. Hessel once kept one this way five weeks. In cold climates they protect themselves from freezing in winter by retiring in groups of fifty to one hundred or more, into cavities in the muddy bottom called 'kettles,' where they pass the time until spring, huddled together in concentric circles, with their heads together, the posterior part of the body raised and held immovable, scarcely lifting the gills for breathing and without taking a particle of food. This abstinence and torpidity lasts in cold countries six or even seven months, and thus they can live out a very rigorous winter.

"In Central Europe its growth is entirely suspended in the winter, the increase in weight taking place from May to August, and especially in July. The rate of growth depends upon many things, the temperature of the water, the quality and quantity of food, the nature of the bottom. In rivers and lakes they attain the greatest size."

In the summer of 1872 the carp was introduced by Mr. Poppe into California from Holstein. As an indication of the value of this fish and what can be accomplished with ordinary care from the stock already distributed, it may be here mentioned that Mr. Poppe succeeded in reaching his ponds in Sonoma county, California, with only five small carp "about the size of a steel pen." These were placed in a pond which had a uniform temperature of about 74° degrees Fahrenheit. Mr. Poppe reports that by May of the following year these fish had increased in length to sixteen inches, and that he secured some three thousand young fish from them. Two of these original fish now survive and are said to be over two feet long and weigh over fifteen pounds a piece. Mr. Poppe has done a very large and thriving business by selling them to stock other ponds. The uniformly warm water which supplies these ponds has no doubt stimulated the growth of the

fish in a great degree, and we cannot, in the colder waters of Maryland, expect such rapid growth and early development; but when it is taken into consideration that to each individual wishing them we have issued twenty fish averaging from three to five inches in length, it should not be many years before the waters of Maryland are well stocked. We are informed that the fish on Mr. Poppe's farm are fed almost wholly on "curd" from the dairy, although this food is sometimes varied by barley, wheat, beans, corn, peas and coagulated blood. Mr. Poppe remarks that "they would eat anything that a hog would." In most of the ponds of Maryland the carp would find a great deal of natural food in the mud, and the aquatic plants would also furnish much food, but where very large numbers are confined in limited waters it will be seen that they can be fed at very small cost. Unfortunately the fish introduced by Mr. Poppe, although the genuine carp, were not of such carefully selected varieties as those brought over by Mr. Hessel, from which the stock in Maryland was derived.

Next spring, before the breeding season, the ponds at Druid Hill Park are to be drawn. Due notice will be given in advance, in order that such of our citizens as desire to propagate this fish may be prepared to receive as many as can be issued.

On the next page will be found a table showing the number of persons and localities reached by the fall and winter distribution.

RECORD OF DISTRIBUTION OF GERMAN CARP *made from November* 1, 1879, *to December* 31, 1879, *by the Maryland Commissioners, under direction of John S. Saunders.*

Date of Transfer.	Obtained from	Place whence taken.	No. of Fish.		Introduction of Fish.			Transfer in charge of, or to whom delivered.
			Orignl'y Taken.	Actually Planted.	Place.	Stream.	Tributary of—	
Nov. 1..	Carp Pond No. 4, Druid Hill Park.	Druid Hill Park.	20	20	....	Stony Run.........	....	J. A. Edmonson.
" 4*.	"	"	250	250	Virginia Commission.......	....	....	Col. McDonald.
" 8..	"	"	20	20	Back River, Md...........	....	....	Henry Lange.
" 8†.	"	"	16	16	Chapel Cove..............	Miles River........	Miles River......	Col. Edward Lloyd.
" 8†.	"	"	16	16	Trappe, Talbot county......	Bartlett's Pond.....	Choptank River..	J. Thos. Bartlett.
" 8†.	"	"	16	16	Eureka Mills, Talbot co.....	Eureka Pond.......	Miles River......	Wm. F. Elben.
" 8†.	"	"	16	16	Bartlett's Mill, Talbot co....	Bartlett's Pond.....	Choptank River..	James C. Tarbutton.
" 8†	"	"	16	16	Trappe, Talbot county......	Wright's Pond.....	Choptank River..	Wm. P. Wright.
" 8†.	"	"	16	16	Trappe, Talbot county......	Collins' Pond.......	Choptank River..	Wm. Collins.
" 8†.	"	"	16	16	Sherwood Mills, Talbot co...	Sherwood Pond....	Skipton Creek....	A. B. Hardcastle.
" 8†.	"	"	16	16	Wye Mills, Talbot co.... ..	Wye Pond.........	Wye River.......	J. R. Hopkins.
" 10*.	"	"	500	500	....	....	....	C. H. Sherman.
" 10*.	"	"	500	500	....	....	....	J. F. Ellis.
" 10..	"	"	20	20	Manor Glen, Balto. co......	Little Gunpowder..	....	R. Emory, M. D.
" 11..	"	"	20	20	Sappington, A. A. co.......	Pond.	Patuxent River...	J. V. Follansbee.
" 11..	"	"	20	20	Cockeysville, Balto. co......	Pond.........	Gunpowder Falls.	A. T. Lore.
" 12..	"	"	20	20	Baltimore, Md.	Pond.....	Jones Falls.......	Wm. Shirley.
" 12..	"	"	1000	1000	Druid Hill Park	Pond No. 4	....	....
" 13..	"	"	20	20	Upper ⋈ Roads, Harford co.	Pond.	Little Gunpowder.	Jos. A. Hayghe.

* Account of United States Fish Commission. † By Mr. Hughlett.

RECORD OF DISTRIBUTION OF GERMAN CARP *made from November* 1, 1879, *to December* 31, 1879, *by the Maryland Commissioners, under direction of John S. Saunders*—Continued.

Date of Transfer.	Obtained from	Place whence taken.	No. of Fish.		Introduction of Fish.			Transfer in charge of, or to whom delivered.
			Orignl'y Taken.	Actually Planted.	Place.	Stream.	Tributary of—	
Nov. 13.	Carp Pond No. 4, Druid Hill P.	Druid Hill Park.	20	20	Hunting Hill, Montgom'y co.	Pond..............	....	E. L. Trichbeleby.
" 13.			20	20	Davidsonville, A. A. co.....	Pond..............	Patapsco River...	Thos. S. Iglehart.
" 13.			20	20	Davidsonville, A. A. co.....	Pond..............	South River......	Jas. A. Iglehart.
" 13*			50	50	Jobstown, N. J...........	....	....	P. Lorillard.
" 13*			30	30	Wenonah, N. J...........	....	....	Milton S. Price.
" 14.			20	20	Ellicott City, Md..........	Pond..............	Patapsco River...	Marcus W. Brown.
" 15.			20	20	Govanstown, Md..........	Pond..............	Lake Roland.....	J. Wilson Brown.
" 15.		"	20	20	Rider's Station, Balto. co....	Pond..............	Lake Roland.....	Isaac Hartman.
" 15.		"	20	20	Parkton, Baltimore co......	Pond..............	Little Gunpowder.	S. V. Trump.
" 17.		"	20	20	Upper ⋈ Roads, Harford co.	Pond..............	Little Gunpowder.	James D Ball.
" 18.		"	20	20	....	Pond..............	Patapsco River...	O. Lugger.
" 19.		"	20	20	Westminster, Md..........	Pond..............	Monocacy River..	W. A. Cunningham.
" 19.		"	20	20	Westminster, Md..........	Pond..............	Monocacy River..	Granv. Coppersmith
" 19.		"	20	20	Taitsburg, Montgomery co..	Pond..............	Potomac River...	W. A. Cocke.
" 19.	" Hatching House.	"	20	20	Upper ⋈ Roads, Harford co	Pond..............	Big Gunpowder..	W. A. Spencer.
" 19†	"	"	80	80	Reedburn, Queen Anne co...	Pond..............	Chester River....	Richard Hollyday.
" 19†	"	"	20	20	Uryville, Kent co..........	Pond..............	Chester River....	Wm. W. McKenett.
" 21.	"	"	20	20	Hereford, Baltimore co......	Pond..............	Gunpowder	T. G. Mitchell.
" 21	"	"	20	20	Davidsonville, A. A. co.....	Pond..............	South River......	Samuel Anderson.

* Account of United States Fish Commission. † By Mr. Hughlett.

RECORD OF DISTRIBUTION OF GERMAN CARP *made from November* 1, 1879, *to December* 31, 1879, *by the Maryland Commissioners, under direction of John S. Saunders*—Continued.

Date of Transfer.	Obtained from	Place whence taken.	No. of Fish.		Introduction of Fish.			Transfer in charge of, or to whom delivered.
			Orignl'y Taken.	Actually Planted.	Place.	Stream.	Tributary of—	
Nov. 22*	Hatching House.	Druid Hill Park.	40	40	Cambridge, Md............	Pond..............	Chicamacomico R.	Geo. J. Meekins.
" 22*	"	"	20	20	Greensborough, Caroline co	Pond..............	Choptank River..	W. H. Comegys
" 22*	"	"	20	20	Greensborough, Caroline co.	Pond..............	Choptank River..	Richard H. Comegys
" 22*	"	"	20	20	Greensborough, Caroline co.	Pond..............	Choptank River..	H. C. Comegys.
" 22*	"	"	20	20	Cambridge, Md............	Pond..............	Chicamacomico R.	Wm. H. Hayward.
" 22*	"	"	86	86	Huntington, Caroline co.....	Pond..............	Choptank River..	Danl. J Waldron.
" 22*	"	"	86	86	Easton, Talbot co..........	Pond..............	Miles River.......	Thomas Hughlett.
" 22.	"	"	20	20	Westminster, Md..........	Pond..............	Patapsco River...	H. S. Mottle.
" 22.	"	"	20	20	Carrolton, Md.............	Pond..............	Patapsco River...	H. S. Weaver.
" 24.	"	"	50	50	Fair View, Prince George co.	Pond..............	....	Oden Bowie.
" 24.	"	"	20	20	Lutherville, Md	Pond..............	Gunpowder.......	George M. Horn.
" 26.	"	"	20	20	Fork Meeting, Baltimore co.	Pond..............	Big Gunpowder...	Chas. J. Riddle.
" 27	"	"	20	20	Pikesville, Md.............	Pond..............	Gwynns Falls.....	Thos. J. Meyer.
" 27.	"	"	30	30	Green Spring, Baltimore co..	Pond..............	....	Saml. Shoemaker.
" 28.	"	"	20	20	Paper Mills, Baltimore co...	Pond..............	Gunpowder.......	Wm. H. Hoffman.
Dec'r 4*	"	"	70	70	Johnson's X Rds, Dorchester	Pond..............	Nanticoke River..	John N. Wright.
" 4*	"	"	20	20	Cambridge, Md............	Pond..............	Transquaking Riv	George J. Meekins.
" 5.	"	"	20	20	Towsontown, Md..........	Pond..............	Jones Falls.......	C. B. Slingluff.
" 4†	"	"	580	580	....	....	....	J. F. Ellis.

* By Mr. Hughlett. † On account of United States Fish Commission.

RECORD OF DISTRIBUTION OF GERMAN CARP *made from November* 1, 1879, *to December* 31, 1879, *by the Maryland Commissioners, under direction of John S. Saunders*—Continued.

Date of Transfer.	Obtained from	Place whence taken.	No. of Fish.		Introduction of Fish.			Transfer in charge of, or to whom delivered.
			Orignl'y Taken.	Actually Planted.	Place.	Stream.	Tributary of—	
Dec'r 6.	Hatching House.	Druid Hill Park.	20	20	Woodsburg, Md.	Pond	Monocacy	Henry Hupman.
" 6.			20	20	Liberty Town, Md	Pond	Monocacy	John F. Eyler.
" 8*			375	375				H. B. Nicolas.
" 8†			500	500				Wm. Hamlen.
" 10.			20	20	Pleasantville, Md	Pond	Little Gunpowder	Samuel G. Scarff.
" 10.			20	20	Pleasantville, Md	Pond	Little Gunpowder	Chas. T. Scarff.
" 11.			20	20	New Market, Md	Pond	Monocacy	Eliza S. Wormley.
" 11.	"	"	20	20	Catonsville	Pond	Gwynns Falls	John W. Long.
" 11.	"	"	20	20	Silver Run, Md.	Pond	Monocacy	Mathias I. Bogan.
" 11.	"	"	20	20	Silver Run, Md	Pond	Monocacy	John W. Rittase.
" 12.	"	"	20	20	Baltimore county	Pond	Gwynns Falls	A. E. Groff.
" 12.	"	"	20	20	Baltimore county	Pond	Gunpowder	J. R. Mordecai
" 13.	"	"	20	20	Baltimore county	Pond	Gunpowder	McDonogh School.
" 13	"	"	20	20	Sulphur Spring, Md.	Pond	Patapsco	Henry Cragg.
" 16‡	"	"	20	20	Easton, Talbot county	Pond		Dr. B. C. Cherbonnier
" 16‡	"	"	20	20	Centreville, Queen Anne co.	Pond		Saml. T. Earle.
" 16‡	"	"	20	20	Greensborough, Caroline co.	Pond		D. J. Zacharias.
" 16‡	"	"	40	40	Milford, Del.			Hon. J. W. Causey.
" 18.	"	"	20	20	Govanstown	Pond	Jones Falls	M. H. Leinkle.

* On account of Virginia Commission. † On account of United States Fish Commission. ‡ By Mr. Hughlett.

RECORD OF DISTRIBUTION OF GERMAM CARP *made from November* 1, 1879, *to December* 31, 1879, *by the Maryland Commissioners, under direction of John S. Saunders*—Continued.

Date of Transfer.	Obtained from	Place whence taken.	No. of Fish.		Introduction of Fish.			Transfer in charge of, or to whom delivered.
			Orignl'y Taken	Actually Planted.	Place.	Stream.	Tributary of—	
Dec. 20*	Hatch'g House	Druid Hill Park	600	600	....	....	....	J. F. Ellis.
" 23.			20	20	Walkersville, Md.	Pond	Monocacy	W. N. Todd.
" 23.			20	20	Walkersville, Md	Pond	Monocacy	W. C. Neidig.
" 29.			20	20	....	....	....	Chas. Walker.
" 30.			20	20	....	....	....	C. Schaeffer.
" 30			20	20	....	....	....	Tho. Engler.
" 30.			20	20	....	....	....	S. Ross.
			6135	6135				

* On account of United States Fish Commission.

OYSTER—(*Ostrea virginiana*).

We have hitherto paid no special attention to one great source of wealth in the State, one of the most important products of our waters, as there exists a department specially charged with the protection of the oysters. But the study of the fishes inhabiting the Chesapeake Bay has necessarily led us to the consideration of the condition of the oyster-beds. As some of our most important fishes derive their food either directly from the oyster, or prey upon smaller fishes which are attracted to the oyster-beds by the parasites which there abound, the occurrence of several varieties in our waters is dependent upon the existence of the oyster-beds.

These considerations have rendered it necessary, for a just appreciation of the subject, that we should make a study of the natural history of this important mollusk. With this object in view, we were fortunate in securing the aid of Dr. W. K. Brooks, associate in Biology of the Johns Hopkins University, and the trustees of the Institution very kindly sanctioned Dr. Brooks' absence for a few weeks prior to the close of the session. Having urged upon Dr. Brooks the importance of commencing his researches early in the spring, he accordingly proceeded to Crisfield in the month of May.

The study of the embryology of the oyster resulted in the acquisition of information which must prove most valuable not only to the inhabitants of the Chesapeake Bay, but to the whole Atlantic Coast. The results of these investigations by Dr. Brooks, and his very able treatise on the embryology of the oyster, will be found in the appendix of this report. It will be seen that these investigations have placed it within our power to multiply the oyster to an indefinite amount, and although the supply has diminished to a very alarming extent, we have now sufficient knowledge to enable us, at any time, to arrest this decrease. A careful examination of the results of Dr. Brooks' researches would indicate the advisability of establishing at some suitable point on the Chesapeake Bay, without delay, a breeding park. This can be done at very little expense, and would be of much importance not only to

enable us to trace the further development of the oyster, but would, no doubt, be of great benefit as a model on which establishments of a similar kind can be constructed.

If the artificial propagation of the oyster prove a success practically, and if the art of manipulating them can be easily acquired, as Dr. Brooks' descriptions would indicate, an almost indefinite supply of young oysters could be derived in this manner, and they could be easily transferred to localities suitable for their final development. Much of the present drain, on the natural beds, for transplanting would become unnecessary, and the supply for cultivation in shoal waters could be derived by this simple artificial propagation. The planted beds could then be furnished at much less expense to the cultivator.

By pursuing this method, the beds would not only be relieved of the necessity for disturbing them during the periods when they should be at rest, but a strong inducement to violate the protective laws would be removed. We feel satisfied that the able Board, under whose special care the oysters are placed, will suggest most proper and efficient means for their protection. We simply place within their reach the results of recent investigations which have been conducted in connection with our study of the waters of the State, and we trust that they will be found to contain something of value. The oyster, as we have already said, must have a very important bearing on the fish yield of our waters, and for this reason is ever a matter of interest to us.

It is well known that quite a large population on the seacoast of France derive their chief support from the cultivation of the oyster, and many of the marine departments owe their prosperity mainly to this industry. The Europeans have, however, confined themselves to collecting, carefully protecting and caring for the oyster after it has reached that stage when it attaches itself to some stationary object. Dr. Brooks has pointed out to us how we can go far beyond the oyster culturists of Europe in being able to artificially impregnate the eggs as in fish culture, and in this way, to a great extent, control the increase.

In the oyster parks of France the success in collecting the spat is dependent oftentimes on the conditions of the water and the season. If the collectors are placed in position too long before the spatting season, they are covered with sediment and lose their capacity for receiving the spat. Again, they are frequently placed in position after the spatting season has advanced, and the yield is consequently much diminished. It will be seen that by artificial impregnation these causes of loss can, to a great extent, be guarded against.

The locality of Crisfield was selected by us after consultation with the Superintendent of the U. S. Coast and Geodetic Survey, as we ascertained that it was proposed to continue, during the summer, the hydrographic investigation which had been commenced in Tangier Sound the previous year. We hoped to be able to combine the results of the investigations of the physical conditions surrounding the oyster-beds with the lessons deduced from the biological investigations, thereby making the work more complete and our conclusions more trusty. The hydrographic investigations were conducted by Master Francis Winslow in the Coast Survey schooner "Palinurus." Through the courtesy of Mr. Carlisle Patterson, Superintendent of the Coast and Geodetic Survey, we have made extracts from the reports of his researches in this locality during the two seasons. These extracts will be found in the appendix.

Early in June, Dr. Brooks was joined by a number of scientific workers connected with the Johns Hopkins and other Universities. For the accommodation of these additional investigators, I secured from the U. S. Commissioner the barges which were used in the shad-hatching operations, and which furnished them with comfortable quarters and quite a commodious laboratory. The small boats of the Fish Commission and a steam launch, which was a part of the shad-hatching equipment, also provided the means of doing a good deal of inshore dredging and surface collecting. The steamer "Lookout," which had been provided with dredging apparatus, was used for dredging in the Sound and Bay and furnished material for study.

We would call your attention to the extracts given from the report of Mr. Winslow, as his investigations clearly show that there has been a very decided decrease of the oysters in the best beds; in fact, that some of them have practically been exhausted. His examinations indicate the necessity of our providing without delay the means of arresting this exhaustion. Although it was impracticable to determine the exact conditions of the beds and the actual amount of the oysters of each class that are to be found, without much more extended investigations than the Coast Survey has yet made, the *relative* conditions of the beds have been pretty well ascertained. It is earnestly hoped that this department will continue the valuable investigations they have commenced, and that we will be able to profit by the cumulative work in this direction.

A careful review of oyster culture in France, the results of the researches of Dr. Brooks, the investigations by the Coast Survey of the beds of Tangier and Pocomoke Sounds, the study of the oyster trade of Maryland and the operations of our oyster police force, causes us to suggest that perhaps the most rational solution that can be arrived at would be the division of the beds of the Chesapeake Bay into sections, and protecting alternately the beds in each section. The period in which the embryo oyster remains unattached, and the distance that the young oysters are carried from the parents during their early life is so great, that the abundance of spat deposited at a given point may not be the result of the fertility of the adults on an adjacent bed. By protecting a bed thoroughly, sufficient spat may be produced from it to provide the surrounding localities, and probably those quite remote.

Conclusion.

We have compiled from the several tables showing the result of the hatching operation during the six years of the existence of the Maryland Fish Commission the following summary, showing the total number of each variety of fish which we have hatched and deposited in the waters of the State:

NAME OF FISH.	1874.	1875.	1876.	1877.	1878.	1879.	TOTAL.
California Salmon.....	144,000	91,500	1,088,304	150.500	710,600	312,236	2,497,140
Shad..................		4,150,000	2,724.000	7,419,300	8.285.000	7,757,000	30.335.300
Land Locked Salmon..			22,600		40,781	26,500	89,881
Smelt..................			3,475	400.000			403,475
Brook Trout...........				50,480	234,500	47.000	331,980
German Carp.........						6,135	6,135
Totals.............	144.000	4.241.500	3.838,379	8.020,280	9.270,881	8,148,871	33 663.911

It will be seen that 33,663,911 fish have been added by artificial means to the waters of the State. Of course many of these have been planted as a matter of experiment and nothing more may ever be heard of them, but each of the varieties experimented with is of such importance that the possibility of a success would warrant the small amount expended on these experiments. The main efforts of the commission have been directed towards the propagation of the salmon, shad and German carp. Of the last two, we are absolutely certain of the great benefits which will be derived. By referring to the only three statements which we have given, those showing the number of shad recorded, as taken in the seines operated at the head of the Bay, as shipped from Havre de Grace, and as inspected in Washington, it will be seen that the increase of shad alone at these points, in the year 1879 over the year previous, amounts to 285,874. It is reasonable to infer that the same increase has taken place in other localities; but did this show the whole increase, and if we value the shad at ten cents each, the increase would represent the sum of $28,587.40, almost three times the annual appropriation for fish culture by the State. This would indicate that our citizens are already deriving adequate results, even if the labors of the commission were limited to the propagation of shad alone. As we have before mentioned, shad ascend the rivers only after they have become adult and are ready to spawn. Therefore the increase of fish in any one year, until a sufficient time has elapsed for the second generation from those hatched artificially, to return, is to be credited to one year's operations only, as the increase of the shad in 79 is most likely attributable solely to the return of those propagated in 76. The work of the succeeding

year 77 and 78 has not influenced at all this increase. The results of the return of the fish hatched during these years will be felt only in subsequent years.

In fulfilling the duties imposed upon us by the act under which the Fish Commission was organized, we cannot do more than call attention to the recommendations for protection which have been made in our previous reports.

The necessity for the construction of a fish-way to enable the migratory fish to ascend the river beyond the Great Falls of the Potomac becomes more urgent each year. For several years we have placed a sufficient number of shad in the upper waters of this river to insure their returning in sufficient numbers to make their presence felt, if proper means are provided for them to overcome this barrier to their ascent. No doubt those fish that have gone down to the sea over the falls will on their return make every effort to ascend them. Great as is the importance of a fish-way at this point to the inhabitants above the falls, it is of almost equal importance to those living below, as it would extend the spawning grounds to a very great extent and insure a future supply to the important fisheries of this river.

The need for efficient protective laws on the Potomac is greatly felt, and we would earnestly urge upon the assemblies of both Virginia and Maryland to pass similar laws protecting the river and giving the officers of the law concurrent jurisdiction.

We take pleasure in repeating our acknowledgments to the several transportation lines for continued courtesies.

Respectfully submitted,

T. B. FERGUSON,
THOS. HUGHLETT,
Commissioners.

APPENDIX.

DEVELOPMENT

OF THE

AMERICAN OYSTER,

BY

DR. W. K. BROOKS.

Development of the American Oyster,

(*Ostrea virginiana List.*)

By W. K. BROOKS,

Associate in Biology, Johns Hopkins University,

BALTIMORE, MD.

At the request of Major Ferguson, Fish Commissioner of Maryland, that I should attempt to trace the development of the young oyster, I made arrangements which enabled me to leave Baltimore a month before the close of my year's work at the University, and the opening of the Seaside Laboratory, Dr. Martin and Dr. Sihler generously taking charge of my classes, and affording me an entire month for uninterrupted work upon the oyster. The United States Coast Survey having determined to continue the examination of the oyster beds of Pokamoke and Tangier Sounds, Major Ferguson was desirous of having the biological investigations commenced in the same locality I therefore arranged to open the Seaside Laboratory of the Johns Hopkins University in June, 1879, at Crisfield, within reach of the great natural oyster beds of Tangier and Pokamoke Sounds.

While I regard the information which I was able to obtain upon certain purely scientific questions in embryology as the most important and valuable result of my summer's work, I am aware that most of the persons who are interested in the habits of the oyster and in oyster culture would not care to read a purely technical embryological paper. It seems best, then, to divide my account into two parts, and to give first a somewhat popular description of the method of artificial fertilization, with a description of a sufficient number of my figures to convey a general idea of the manner of develop-

ment, and then to complete the paper in a second part, devoted to a minute description of the figures, a discussion of the theoretical and comparative bearings of my observations and a notice of the observations and views of others.

The place which was selected was excellently fitted for the work. The town of Crisfield, Md., is situated at the junction of Tangier and Pokomoke Sounds, two large and wide but shallow sheets of water, whose muddy bottoms abound in oysters of the best quality. The town is one of the most important centres of the oyster-packing industry, and is built in the water upon the shells of the oysters, which have been shipped to all parts of the country for consumption. As fast as the oysters are opened the shells are used to build up new land, and with them a large peninsula has been formed, stretching out for more than half a mile from the low marshy shore towards the oyster beds, and furnishing room for wide streets, a railroad and a steamboat landing, in addition to the large packing houses and the shops and dwellings for a population of several thousand people. A single view of the long, white, solid streets and docks of this singular town would convey a much more vivid idea of the oyster-packing industry than any number of tables of statistics.

I found everybody greatly interested in all that relates to the oyster, and ready to give me every help in my work, but I am especially indebted to Dr. H. H. Gunby, Mr. T. S. Hodson and Mr. J. J. Lawson for many kindly favors, which not only enabled me to work to the greatest advantage, but also rendered my stay among them very pleasant.

BREEDING HABITS OF THE AMERICAN OYSTER.

Our knowledge of the development of the oyster is derived from the fragmentary observations of various German, French, English and Russian embryologists, whose work will be noticed at length further on. While the subject has received the attention of a number of observers, no one has been able to get anything like a complete series of the early stages of development, and I approached my work without hope of ac-

complishing much of purely scientific value, although I did expect to obtain some information as to the time and conditions of spawning, and other questions of economic interest. My uncertainty of success was increased by the total failure of an attempt which I had made the summer before.

All the published papers upon the subject state that the eggs are fertilized inside the body of the parent, and that the young are carried inside the parent shell until they are quite well advanced in development, and provided with shells of their own; that they swim about after they are discharged from the parent until they find a place to attach themselves, but that they undergo no change of structure between the time when they leave the parent and the time when they become fixed. Misled by these statements, which are not true with our species, I opened numbers of oysters during the summer of 1878, and carefully examined the contents of the gills and mantle chambers, but found no young oysters. I concluded that the time during which the young are carried by the parent must be so short that I had missed it, and I entered upon the work this season with the determination to examine adult oysters every day, through the breeding season, in search of young, and at the same time to try to raise the young for myself by artificially fertilizing the eggs after I had removed them from the body of the parent.

I met with complete success with the second method from the beginning, and succeeded in raising countless millions of young oysters, and in tracing them through all their stages of development until they had acquired all the characteristics which the European embryologists have described and figured in the young of the European oyster at the time it leaves its parent to become fixed for life.

I reached Crisfield on the 19th of May, and established myself about three miles from the town and about half a mile from Pokamoke Sound, and on Monday, the 21st, I opened a dozen fresh oysters, and found three females with their ovaries filled with ripe ova, and one male with ripe spermatoza.

I mixed the contents of the reproductive organs of these four oysters, and within two hours after the commencement

of my first experiment, I learned by the microscope that the attempt at artificial fertilization was successful, and that nearly all of my eggs had started on their long path towards the adult form.

I made careful microscopic examination of the gills and mantles of all these oysters, but neither at this time nor afterwards did I find any fertilized eggs or young inside the parent shell, although I examined more than a thousand adults during the season. During the summer I found females with the ovaries so distended with ripe eggs that they were oozing from the openings of the oviducts; others where the ovaries were half emptied, and others which had discharged almost all their eggs, and others at all the intermediate stages, but in no case did I find a single developing egg inside the shell of the parent.

I have accumulated enough evidence to show beyond the possibility of doubt, that so far as the oysters of the Chesapeake Bay, during the summer of 1879, are concerned, the eggs are fertilized outside the body of the parent, and that, during the period which the young European oyster passes inside the mantle cavity of its parent, the young of our oyster swims at large in the open ocean.

While this evidence cannot be regarded as sufficient to show that the young of the American oyster are never carried by their parents, it is certainly enough to show that this cannot be assumed from the analogy of the European oyster. Most of the popular treatises on the use of the microscope state that during the summer young oysters may be found inside the shells of the old ones, and as the number of amateur workers with the microscope in this country is quite large, I should be glad to learn whether any one has ever found this to be the case with American oysters.

Until some such evidence is produced it is fair to conclude that my results are to be applied to all the American oysters, and that there is a very important difference between them and the European species.

ANATOMICAL OUTLINE SKETCH.

The thorough study of the anatomy of the adult oyster is rather difficult, but there is no difficulty in gaining all the knowledge which is needed for procuring and fertilizing the eggs. As I hope that a way will be found to turn my observations to practical account in oyster culture, I will give a very brief sketch of the structure of the oyster—such a sketch as will enable any one who reads it with an opened oyster before him to acquire the necessary anatomical knowledge. It is hardly possible to write such a description without using a few technical terms, such as anterior and posterior, dorsal and ventral. As the end of the body where the mouth is placed is not marked by a head, it must be spoken of as the *anterior end*, not as the *head*, and the opposite end as the *posterior*. As the oyster lies on one side, the *top* and *bottom* of its body do not correspond to the regions which occupy these positions in an upright mussel or clam, and it is most convenient to speak of that part of the oyster's body which answers to the upper surface of a clam as dorsal and the opposite as ventral.

The general structure of an oyster may be roughly represented by a long narrow memorandum book, with the back at one of the narrow ends instead of at one of the long ones. The covers of such a book represent the two shells of the oyster and the back represents the hinge, or the area where the two valves of the shell are fastened together by the hinge ligament. This ligament is an elastic, dark brown structure, which is placed in such a relation to the valves of the shell that it tends to throw their free ends a little apart. In order to understand its manner of working, open the memorandum book and place between its leaves, close to the back, a small piece of rubber to represent the ligament. If the free ends or the cover are pulled together the rubber will be compressed and will throw the covers apart as soon as they are loosened. The ligament of the oyster-shell tends by its elasticity to keep the shell open at all times, and while the oyster is lying un-

disturbed upon the bottom, or when its muscle is cut, or when the animal is dying or dead, the edges of the shell are separated a little.

The shell is lined by a thin membrane, the mantle, which folds down on each side, and may be compared to the leaf next the cover on each side of the book. The next two leaves of each side roughly represent the four gills, the so-called "beard" of the oyster, which hang down like leaves into the space inside the two lobes of the mantle. The remaining leaves may be compared to the body or *visceral mass* of the oyster.

Although the oyster lies upon the bottom with one shell above and one below, the shells are not upon the top and bottom of the body, but upon the right and the left sides. The two shells are symmetrical in the young oyster, but after it becomes attached the lower or attached side grows faster than the other, and becomes deep and spoon-shaped, while the free valve remains nearly flat. In nearly every case, the lower or deep valve is the left. As the hinge marks the anterior end of the body, an oyster which is held on edge with the hinge away from the observer and the flat valve on the right side, will be placed with its dorsal surface uppermost, its ventral surface below, its anterior end away from the observer, and its posterior end towards him, and its right and left sides on his right and left hands respectively.

In order to examine the soft parts, the oyster should be opened by gently working a thin flat knife blade under the posterior end of the right valve of the shell, and pushing the blade forwards until it strikes and cuts the strong adductor muscle, which passes from one shell to another and pulls them together. As soon as this muscle is cut the valves separate a little, and the right valve may be raised up and broken off from the left, thus exposing the right side of the body. The surface of the body is covered by the mantle, a thin membrane which is attached to the body over a great part of its surface, but hangs free like a curtain around nearly the whole circumference. By raising its edge, or gently tearing the whole right half away from the body, the gills will be exposed.

These are four parallel plates which occupy the ventral half of the mantle cavity and extend from the posterior nearly to the anterior end of the body. Their ventral edges are free, but their dorsal edges are united to each other, to the mantle and to the body. The space above or dorsal to the posterior ends of gills, is occupied by the oval, firm, adductor muscle, the so-called "heart." For some time I was at a loss to know how the muscle came to be called the heart, but a friend told me that he had always supposed that this was the heart, since the oyster dies when it is injured. The supposed "death" is simply the opening of the shell when the animal looses the power to keep it shut. Between this muscle and the hinge the space above the gills is occupied by the body, or *visceral mass*, which is made up mainly of the light colored reproductive organs and the dark colored digestive organs, packed together in one continuous mass.

If the oyster has been opened very carefully, a transparent crescent-shaped space will be seen between the muscle and the visceral mass. This space is the pericardium, and if the delicate membrane which forms its sides be carefully cut away the heart may be found without any difficulty, lying in this cavity, and pulsating slowly. If the oyster has been opened roughly, or if it has been out of water for some time, the rate of beating may be as low as one a minute, or even less, so the heart must be watched attentively for some time in order to see one of the contractions.

The heart is made up of two chambers, a loose spongy transparent *auricle*, which occupies the lower part of the pericardium, and receives blood from the gills through transparent blood vessels, which may usually be seen without difficulty running from the gills towards the heart, and a more compact white *ventricle*, which drives the blood out of the pericardium through transparent arteries, which are usually quite conspicuous.

The visceral mass is prolonged backwards over the pericardium and the adductor muscles, and here contains the rectum surrounded by prolongations of the white reproductive or-

gans. Still farther back, on the middle of the posterior face of the adductor muscle, is the anus, a long vertical slit, opening into the space between the lobes of the mantle and above the posterior ends of the gills.

In front of the gills, that is between them and the hinge, there are four fleshy flaps—the lips—two on each side of the body. They are much like the gills in appearance, and they are connected with each other by two ridges which run across the middle of the body close to the anterior end, and between these folds is the large oval mouth, which is thus seen to be situated, not at the open end of the shell, but as far away from it as possible. As the oyster is immovably fixed upon the bottom, and has no arms or other structures for seizing food and carrying it to the mouth, the question how it obtains its food at once suggests itself. If a fragment of one of the gills is examined with a microscope, it will be found to be covered with very small hairs, or *cilia*, arranged in rows. Each of these cilia is constantly swinging back and forth, with a motion something like that of an oar in rowing. The motion is quick and strong in one direction and slower in the other. As all the cilia of a row swing together, they act like a line of oars, only they are fastened to the gill, and as this is immovable, they do not move forwards through the water, but produce a current of water in the opposite direction. This action is not directed by the animal, for it can be observed for hours in a fragment cut out of the gill, and if such a fragment be supplied with fresh sea water, the motion will continue until it begins to decay. While the oyster lies undisturbed on the bottom, with its muscle relaxed and its shell open, the sea water is drawn on to the gills by the action of the cilia, for although each cilium is too small to be seen without a microscope, they cover the gills in such great numbers that their united action produces quite a vigorous stream of water, which is drawn through the shell and is then forced through very small openings on the surfaces of the gills into the *water tubes*, inside the gills, and through these tubes into the mantle cavity, and so out of the

shell again. As the stream of water passes through the gills the blood is aerated by contact with it. The food of the oyster consists entirely of minute animal and vegetable organisms and small particles of organized matter. Ordinary sea water contains an abundance of this sort of food, which is drawn into the gills with the water, but as the water strains through the pores into the water tubes, the food particles are caught on the surface of the gills by a layer of adhesive slime which covers all the soft parts of the body. As soon as they are entangled the cilia strike against them in such a way as to roll or slide them along the gills towards the mouth. When they reach the anterior ends of the gills they are pushed off and fall between the lips, and these again are covered with cilia, which carry the particles forwards until they slide into the mouth, which is always wide open and ciliated, so as to draw the food through the œsophagus into the stomach. Whenever the shell is open these cilia are in action, and as long as the oyster is breathing a current of food is sliding into its mouth.

The cilia and particles of food are too small to be seen without a microscope, but if finely powdered carmine be sprinkled over the gills of a fresh oyster, which has been carefully opened and placed in a shallow dish of sea water, careful observation will show that as soon as the colored particles touch the gills they begin to slide along with a motion which is quite uniform, but not much faster than that of the minute hand of a watch.

This slow, steady, gliding motion, without any visible cause, is a very striking sight, and with a little care the particles may be followed up to and into the mouth.

In order to trace the course of the digestive organs, the visceral mass may be split with a sharp knife or razor. If the split is pretty near the middle of the body, each half will show sections of the short, folded œsophagus, running upwards from the mouth, and the irregular stomach, with thick semi-transparent walls, surrounded by the compact, dark

greenish liver. Back of the liver and stomach the convoluted intestine will be seen, cut irregularly at several points by the section.

The coils of the intestine are imbedded in a light-colored mass of tissue—the reproductive organ—which forms the greater part of the visceral mass. The reproductive organ varies greatly according to the season, and forms most of what is known as the "fat" of the oyster.

There are no accessory organs of reproduction, and the position, form and general appearance of the reproductive organ is the same in both sexes. There is no characteristic by which a male oyster can be distinguished from a female without microscopic examination. As the reproductive organ has an opening on each side of the body, it is usually spoken of as double, but in the adult oyster it forms one continuous mass, with no trace of a division into halves, and extends entirely across the body and into all the bends and folds of the digestive tract.

As my observations only extend over one summer, I cannot make any general statements as to the breeding season, except that the oysters in shallow water spawn first, and those in deeper water later, as the water becomes warmer. Nearly all the oysters in shallow water spawn at about the same time, but there is more difference in the oysters taken from the same bed in deep water. Oysters in from one to six feet of water in the vicinity of Crisfield, probably spawn between the middle and end of May, but oysters with ripe eggs were found in water from five to six fathoms deep from the 1st to the 30th of July, although most of them spawn late in June.

ARTIFICIAL IMPREGNATION OF THE OYSTER EGGS.

If a number of oysters are opened during the breeding season, a few will be found with the reproductive organ greatly distended and of an uniform pure opaque white color. These are oysters which are spawning or nearly ready to spawn.

If the point of a knife be pushed into the reproductive organ a milk-like fluid will ooze out of the cut, and a little of it may be taken up on a knife blade and transferred to a glass slide for examination. The drop of fluid should be thoroughly mixed with a drop of sea water and placed on the slide, and gently covered with a cover-glass, and examined with a magnifying power of about one hundred diameters. If the specimen is a female, this power will show that the white fluid is almost entirely made up of irregular pear-shaped ovarian eggs (Figure 49), each of which contains a large circular transparent germinative vesicle surrounded by a layer of granular slightly opaque yolk. It is almost impossible to describe the slight differences which distinguish the perfectly ripe egg from those which are nearly ripe but not capable of fertilization, although a very little experience will enable one to tell whether it is worth while to attempt the fertilization of the eggs of any given female.

When the drop of fluid is thoroughly mixed with the sea water, the eggs should appear clean, sharply defined, separate from each other, and pretty uniformly distributed through the drop, as shown in the figure. If they adhere to each other, or if their outlines are indistinct, or if there is much fine granular matter scattered between the eggs, it is probable that the attempt at artificial fertilization will at best be only partially successful.

When a perfectly ripe female is found, it should be set aside and the search continued for a male. The question of the sex of the oyster has long been a matter of dispute, and the subject will be fully discussed in another place. All that concerns us now is to know that for all practical purposes the sexes are separate in the European as well as the American oyster. At the breeding season each individual is either exclusively a male or exclusively a female. Out of several thousand which I examined, I have not found one which contained both eggs and male cells, and all the best authorities upon the European oyster make the same statement, although there is some reason for the belief that an oyster may give

rise to eggs one season and to male cells another year. When a drop of the milky fluid from a ripe male is mixed with a little sea water and examined with a magnifying power of one hundred diameters, it is seen at a glance to be quite different from the fluid of a female. There are no large bodies like the eggs, but the fluid is filled with innumerable numbers of minute granules (Figure 48), which are so small that they are barely visible when magnified one hundred diameters. They are not uniformly distributed, but are much more numerous at some points than at others, and for this reason the fluid has a cloudy or curdled appearance. By selecting a place where the granules are few and pretty well scattered, very careful watching will show that each of them has a lively dancing motion, and examination with a power of five hundred diameters will show that each of them is tadpoll-shaped (Figure 50), and consists of a small, oval, sharply defined "head" and a long, delicate "tail," by the lashing of which the dancing is produced.

It is more difficult to decide whether the male cells are perfectly ripe than it is to decide in the case of the eggs. With a magnifying power of five hundred diameters, each "head" should have a clear, well-marked outline, and they should be very uniform in size, and separated from each other, as in Figure 50. Under very favorable circumstances this power should also show the "tails," as very faint undulating lines.

If the "heads" vary much in size, or if they are aggregated into bunches, with the "tails" radiating from the bunches in all directions, or if there is much granular matter so small that the outlines of the particles are not visible when magnified five hundred diameters, the fluid is not perfectly ripe, aud fertilization with it will not in all probability be very successful.

NUMBER OF EGGS.

As the male cells are infinitely more numerous than the eggs, the ripe fluid from even one small male is enough to fertilize all the eggs of five or six large females.

The number of male cells which a single male will yield is great beyond all power of expression, but the number of eggs which an average female will furnish may be estimated with sufficient exactness. A single ripe egg measures about one five hundredth of an inch in diameter, or five hundred laid in a row, touching each other, would make one inch; and a square inch would contain five hundred such rows, or 500 x 500 = 250,000 eggs. Nearly all the eggs of a perfectly ripe female may be washed out of the ovary into a beaker of sea water, and as they are heavier than the sea water, they soon sink to the bottom, and the eggs of a medium sized female will cover the bottom of a beaker two inches in diameter with a layer of eggs one-twentieth of an inch deep. The area of the bottom of a beaker two inches in diameter is a little more than three square inches, and a layer of eggs one-twentieth of an inch deep, covering three square inches, is equal to one three-twentieths of an inch deep and two square, and as a single layer of eggs is one-five-hundredth of an inch thick, a layer three-twentieths of an inch thick will contain seventy-five layers of eggs, with 250,000 eggs in each layer, or 18,750,000 eggs. It is difficult to get the eggs perfectly pure, and if we allow one-half for foreign matter and errors of measurement, and for imperfect contact between the eggs, we shall have more than nine millions as the number of eggs laid by an oyster of average size, a number which is probably less than the true number.

Möbius estimates the number of eggs laid by an average European oyster at 1,012,925, or only one-ninth the number laid by an ordinary American oyster, but the American oyster is very much larger than the European, while its eggs are less than one-third as large, so the want of agreement between these estimates does not indicate that either of them is incorrect.* Another estimate of the number of eggs

*Möbius' measurement, from .15 to .18 millimeters, is given (Austern und Austern-wirtschaft, 1877), as the diameter, not of the egg, but of the embryo, but his figures show that the European oyster, like the American, does not grow much during the early stages of development, but remains of about the same size as the egg.

laid by the European oyster is given by Eyton, (History of the Oyster and Oyster Fisheries, by T. C. Eyton. London: 1858). He says, p. 24, that there are about 1,800,000, and therefore agrees pretty closely with Möbious.

An unusually large American oyster will yield nearly a cubic inch of eggs, and if these were all in absolute contact with each other, and there were no portions of the ovaries or other organs mixed with them, the cubic inch would contain 500^3, or 125,000,000. Dividing this, as before, by two, to allow for foreign matter, interspaces and errors of measurement, we have about 60,000,000 as the possible number of eggs from a single oyster.

Although each male contains enough fluid to fertilize the eggs of several females, there does not seem to be much difference in the number of individuals of the two sexes. When a dozen oysters are opened and examined, there may be five or six ripe females and no males, but in another case a dozen oysters may furnish several ripe males but no females, and in the long run the sexes seem to be about equally numerous. Oystermen believe that the male may be distinguished from the female by certain characteristics, such as the presence of black pigment in the mantle, but microscopic examination shows that these marks have no such meaning, and that there are no differences between the sexes except the microscopic ones. It is not necessary to use the microscope in every case, however, for a little experience will enable a sharp observer to recognize a ripe female without the microscope. If a little of the milky fluid from the ovary of a female with ripe or nearly ripe eggs, be taken upon the point of a clean, bright knife blade, and allowed to flow over it in a thin film, a sharp eye can barely detect the eggs as white dots, while the male fluid appears perfectly homogeneous under the same circumstances, as do the contents of the ovary of an immature female, or one which has finished spawning. When the eggs are mixed with a drop of water, they can be diffused through it without difficulty, while the male fluid is more adhesive and difficult to mix with the water. By these indications, I was

able in nearly every case to judge of the sex of the oyster before I had made use of the microscope.

In order to fertilize the eggs, all that is necessary is the mixture of the ripe eggs with a little of the ripe male fluid in a drop of water. If the point of a knife-blade be dipped in the fluid from a female and touched to a glass slide, and then dipped into the fluid of a male and touched to the same part of the slide, and a drop of sea water be added, to cause the two to meet, most of the eggs will be fertilized, and their early stages of development can be studied in a single drop of water, but to secure the fertilization and healthy development of large numbers of eggs, several precautions are necessary, as well as a few instruments and pieces of apparatus.

The following is a list of the things needed for procuring, fertilizing and hatching the eggs: A pair of sharp-pointed scissors; a pair of small forceps; half a dozen watch crystals; a set of about half a dozen glass beakers, or tumblers, of different sizes, from half a pint up to half a gallon; two or three dipping tubes, or glass tubes six or eight inches long, open at both ends, but with one end drawn out to a fine point; a small glass or rubber siphon for drawing the water out of the beakers. For tracing the development of the eggs, a microscope, magnifying at least one hundred diameters, and half a dozen glass slides and thin glass covers are wanted.

After the oysters have been opened, and at least one ripe male and one ripe female found, cut off the mantle lobes and gills of the male with the scissors, close to the visceral mass, and tear them out with the forceps and throw them away. Cut around the adductor muscle with the scissors, so that the visceral mass may be lifted out of the shell and transferred to a small saucer or to a watch crystal. Holding the visceral mass with the forceps, cut out with the scissors as much as possible of the digestive organs and liver and throw them away, and then chop up the reproductive organs with the scissors, picking out and throwing away any fragments of the liver, digestive organs, mantle or gills which may present themselves. In order to have the young oyster thrive, the

water must be kept free from fragments of the various organs of the adult, as these would soon decay and destroy the embryos, and it is therefore important to remove them as completely as possible. After the mass has been chopped up as fine as possible, fill up the watch crystal with fresh sea water, stir it up, and then allow it to run into one of the smallest beakers, which has been nearly filled with sea water. As the water runs out of the watch crystal, be careful to allow as few of the fragments as possible to run with it.

Now fill up the watch crystal with water again, and stir and pour off as before, and repeat the process until nearly all of the male fluid has been washed out of the fragments and poured into the beaker. Stir the contents of the beaker for a short time, and then allow it to stand about five minutes, to allow any fragments to settle to the bottom, then pour the fluid, which should be quite milky, into another small beaker, leaving behind, to be thrown away, any particles which may have settled to the bottom. The male cells retain their full vitality for several hours after they have been mixed with sea water, so the beaker may be set aside to wait until the eggs are ready. The eggs swell up and break to pieces within a very few minutes after they are mixed with water, unless they are fertilized at once, so it is much better to add the eggs to a previously prepared mixture of male cells and water than it is to put the eggs into the water to wait until the male fluid is got ready.

Taking now one of the females, remove and chop up the ovary in the same way in another watch crystal, observing the same precautions in removing all portions of the body. Fill the watch glass with water, and stir and pour off into the beaker as before, giving the contents of the beaker a good stirring after each lot of eggs is added, in order to diffuse them through the water at once, and thus insure the speedy contact of each of them with some of the male cells.

Fill the crystal with water again, and stir and pour off, and repeat until all the eggs have been washed out of the fragments of the ovary.

Another female may now be cut up, and the eggs may be added to the contents of the same beaker, but if the females are large, and yield many eggs, it is not best to use more than one, for although there are enough male cells to fertilize a very great number of eggs, the eggs are heavier than water and soon sink to the bottom, and if they form a very thick layer, only those which lie near the surface have room to develop.

The beaker should now be allowed to stand for about ten minutes, and in the meantime some of the eggs may be picked out with a dipping tube for examination under the microscope. In using the dipping tube, cover the large end with the tip of the finger, and run the small end down close to the bottom of the beaker, and then take the finger off the top, and as the water runs in at the bottom it will carry some of the eggs with it. When the tube is filled, place the finger on the top again, and draw it out of the water, and, holding it perpendicularly on the centre of a glass slide, and taking the finger off the top, allow a good sized drop to run out into the slide.

If things are working properly, each egg should now have a number of male cells attached by their heads to its outer surface, with their tails radiating from it in all directions, as shown in Figure 51.

It is not necessary that more than one male cell should fasten onto each egg, but they usually cover them in such numbers that the lashing of their tails causes the eggs to rotate and move through the water.

As soon as all the eggs have male cells attached to them, it is necessary to get rid of the superfluous male fluid, for it would soon decay and pollute the water if it were allowed to remain, and if it is not drawn off from the eggs while they are at the bottom, it is almost impossible to remove it after the embryos have begun to swim, without loosing them as well.

After a final stirring, the beaker should be allowed to stand for about five minutes, to allow the eggs to settle to the bottom, and the fluid above them should then be drawn off

through a siphon, reaching nearly but not quite down to the eggs. A fresh supply of sea water should then be added, and the eggs stirred and allowed to settle, and the water drawn off as before, and this should be repeated until the water, after the eggs have settled to the bottom, remains clear.

The beaker may now be set aside where it will not be exposed to sudden changes of temperature, and the eggs will require no further attention until the embryos begin to swim, which will be in from two to six hours, according to the temperature. The little oysters must of course be supplied with fresh sea water from time to time during their development, and as they are so small that the water cannot be drawn off after they begin to swim, they must be supplied with fresh water by transferring them from time to time to larger and larger beakers. In two hours or so after the eggs are fertilized the embryos begin to swim, and crowd to the surface of the water in great numbers, and form a thin stratum close to the surface. This layer of embryos may be carefully siphoned off into a very small beaker, and a little fresh sea water added. In an hour or so there will be a new layer of embryos at the surface of beaker No. 1, and these should also be siphoned into No. 2, and this should be repeated as long as the embryos continue to rise to the surface of the first beaker. Every five or six hours a little fresh sea water should be poured from a height of a foot or more into beaker No. 2, until it is filled. The contents should then be poured into a larger beaker, and sea water added four or five times a day as before. In this way the embryos may be kept alive for a week, although they have by this time got into such a large vessel that it is almost impossible to find any of them for microscopic examination.

THE DEVELOPMENT OF THE EGGS.

I will now attempt a brief popular account of the changes through which the fertilized egg is gradually converted into the complex body of the adult oyster.

The body of the oyster, like that of all animals, except the very simplest, is made up of organs such as the heart, digestive organs, gills and reproductive organs, and these organs are at some period in the life of the oyster made up of microscopic cells. The eggs shown in Figures 49 and 53, will answer to illustrate the character of the cells which compose the body; each of these consists of a layer of protoplasm around a central nucleus, which, in the egg, is a large, circular, transparent body known as the germinative vesicle. Each cell of the body is able to absorb food, to grow and to multiply by division, and thus to contribute to the growth of the organ of which it forms a part. The ovarian eggs are simply the cells of an organ of the body, the ovary, and they differ from the ordinary cells only in being much larger and more distinct from each other; and they have the power, when detached from the body, of growing and dividing up into cells, which shall shape themselves into a new organism like that from whose body the egg came. Most of the steps in this wonderful process may be watched under the microscope, and owing to the ease with which the eggs of the oyster may be obtained, this is a very good egg to study.

About fifteen minutes after the eggs are fertilized, they will be found to be covered with male cells, as shown in Figure 51. In about an hour the egg will be found to have changed its shape and appearance. It is now nearly spherical, as shown in Figure 1, and the germinative vesicle is no longer visible. The male cells may or may not still be visible upon the outer surface. In a short time a little transparent point makes its appearance on the surface of the egg, and increases in size, and soon forms a little projecting transparent knob—the *polar globule*—which is shown in Figure 3, and in succeeding figures.

Recent investigations tend to show that while these changes are taking place one of the male cells penetrates the protoplasm of the egg and unites with the germinative vesicle, which does not disappear, but divides into two parts, one of

which is pushed out of the egg, and becomes the polar globule, while the other remains behind and becomes the *nucleus* of the developing egg, but changes its appearance so that it is no longer conspicuous. The egg now becomes pear-shaped, with the polar globule at the broad end of the pear, and this end soon divides into two parts, so that the egg (Figure 6), is now made of one large mass and two slightly smaller ones, with the polar globule between them.

The later history of the egg shows that at this early stage the egg is not perfectly homogeneous, but that the protoplasm which is to give rise to certain organs of the body, has separated from that which is to give rise to others.

If the egg at the stage shown in Figure 6, were split in the plane of the paper, we should have what is to become one half of the body in one part and the other half in the other. The single spherule at the small end of the pear is to give rise to the cells of the digestive tract of the adult, and to those organs which are to be derived from it, while the two spherules at the small end are to form the cells of the outer wall of the body and the organs which are derived from it, such as the gills, the lips and the mantle, and they are also to give rise to the shell. The upper portion of the egg in this and succeeding figures is to become the ventral surface of the adult oyster, and the surface which is on the right side in Figure 6 is to become the anterior end of the body of the adult. The figure therefore shows the half of the egg which is to become the left half of the body. The upper portion of the egg soon divides up into smaller and smaller spherules, until at the stage shown in Figures 24, 25 and 26, we have a layer of small cells wrapped around the greater part of the surface of a single large spherule, and the series of figures shows that the latter is the spherule which is below in Figure 6. This spherule now divides up into a layer of cells, and at the same time the egg, or rather the embryo, becomes flattened from above downward, and assumes the shape of a flat oval disk. Figures 29 and 30, are views of the upper and lower surface of the embryo at about this time.

In a sectional view, Figure3 1, it is seen to be made up of two layers of cells; an upper layer of small transparent cells, *ec*, which are to form the outer wall of the body, and which have been formed by the division of the spherules which occupy the upper end of the egg in Figure 25, and a lower layer of much larger, more opaque cells, *g*, which are to become the walls of the stomach, and which have been formed by the division of the large spherule, *a*, of Figure 25.

This layer is seen in the section to be pushed in a little towards the upper layer, so that the lower surface of the disk-shaped embryo is not flat, but very slightly concave. This concavity is destined to grow deeper until its edges almost meet, and it is the rudimentary digestive cavity. A very short time after this stage has been reached, and usually within from two to four hours after the eggs were fertilized, the embryo undergoes a great change of shape, and assumes the form which is shown in three different views in Figures 32, 33, 34 and 35.

A circular tuft of long hairs or cilia has now made its appearance at what is thus marked as the anterior end of the body, and as soon as these hairs are formed they begin to swing backwards and forwards in such a way as to constitute a swimming organ, which rows the little animal up from the bottom to the surface of the water, where it swins around very actively by the aid of its cilia. This stage of development, Figure 32, which is of short duration, is of great importance in raising the young oysters, for it is the time when they can best be siphoned off into a separate vessel and freed from the danger of being killed by the decay of any eggs which may fail to develop. On one surface of the body at this stage, the dorsal surface, there is a well marked groove, and when a specimen is found in a proper position for examination, the opening into the digestive tract is found at the bottom of this groove. Figure 33, is a sectional view of such an embryo. It is seen to consist of a central cavity, the digestive cavity, which opens externally on the dorsal surface of the body by a small orifice, the primitive mouth, and which is surrounded at all points, except at the mouth, by a wall

which is distinct from the outer wall of the body. Around the primitive mouth these two layers are continuous with each other.

The way in which this cavity, with its wall and external opening, has been formed, will be understood by a comparison of Figure 33, with Figure 28. The layer which is below in Figure 28 has been pushed upwards in such a way as to convert it into a long tube, and at the same time the outer layer has grown downwards and inwards around it, and has thus constricted the opening. The layer of cells which is below in Figure 28 thus becomes converted into the walls of the digestive tract, and the space which is outside and below the embryo, in Figure 28, becomes converted into an inclosed digestive cavity, which opens externally by the primitive mouth.

This stage of development, in which the embryo consists of two layers, an inner layer surrounding a cavity which opens externally by a mouth-like opening, and an outer layer, which is continuous with the inner around the margins of the opening, is of very frequent occurrence, and it has been found, with modifications, in the most widely separated groups of animals, such as the star-fish, the oyster and the frog, and some representatives of all the larger groups of animals, except the Protozoa, appear to pass during their development through a form which may be regarded as a more or less considerable modification of that presented by our oyster embryo. This stage of development is known as the *gastrula* stage.

Certain full grown animals, such as the fresh water hydra and some sponges, are little more than modified gastrulas. The body is a simple vase, with an opening at one end communicating with a digestive cavity, the wall of which is formed by a layer of cells, which is continuous around the opening with a second layer which forms the outer wall of the body. This fact, together with the fact that animals of the most widely separated groups pass through a gastrula stage of development, has lead certain naturalists to a generalization, which is known as the "gastrula theory." This theory or hypothesis is that all animals, except the Protozoa, are more or less direct

descendants of one common but very remote ancestral form, whose body consisted of a simple two-walled vase, with a central digestive cavity opening externally at one end of the body.

Hæckel, who is the originator and leading advocate of this hypothesis, has proposed to call this ancestral form a "Gastraea;" and the gastrula stage of development he regards as a trace or indication of this distant ancestry, which is still retained and passed through during the early stages of the development of animals which are now very widely separated.

The gastrula theory cannot be regarded as one of the established generalizations of science, and the evidence which has so far been accumulated by embryologists is not by any means straightforward or satisfactory. The theory is one of the most interesting embryological problems under discussion, however, and any new information which bears upon it is of value.

The fact that the oyster goes through a very well marked and very slightly modified gastrula stage is therefore of great theoretical interest, and more so since Salensky, a distinguished Russian embryologist, has proposed in place of the gastrula theory another theory, which is based, in part, upon erroneous observations upon the development of the oyster, which Salensky says does not pass through the gastrula stage of development at all, but forms a digestive cavity in another way.

The edges of the primitive mouth of the oyster continue to approach each other, and finally meet and unite, thus closing up the opening, as shown in Figure 36, and leaving the digestive tract without any communication with the outside of the body, and entirely surrounded by the outer layer. The embryo shown in Figures 32 and 36 are represented with the dorsal surface below, in order to facilitate comparison with the adult, but in Figure 37, and most of the following figures, the dorsal surface is uppermost, for more ready comparison with the adult. The furrow in which the primitive mouth was placed still persists, and soon a small irregular plate makes its appearance at each end of it. These

little plates are the two valves of the shell, and in the oyster they are separated from each other from the first, and make their appearance independently.

Soon after they make their appearance, the embryos cease to crowd to the surface of the water, and sink to various depths, although they continue to swim actively in all directions, and may still be found occasionally, close to the surface. The region of the body which carries the cilia now becomes sharply defined, as a circular projecting pad, the *velum*, and this is present and is the the organ of locomotion at a much later stage of development. It is shown at the right side of the figure in Figure 37, and in Figure 45 it is seen in surface view, drawn in between the shells, and with its cilia folded down and at rest, as they are seen when the little oyster lies upon the bottom.

The two shells grow rapidly, and soon become quite regular in outline, as shown in Figures 37 and 44, but for some time they are much smaller than the body, which projects from between their edges around their whole circumference, except along a short area, the area of the hinge, upon the dorsal surface, where the two valves are in contact.

The two shells continue to grow at their edges, and soon become large enough to cover up and project a little beyond the surface of the body, as shown in Figure 44, and at the same time muscular fibres make their appearance and are so arranged that they can draw the edge of the body and the velum in between the edges of the shell, in the manner shown in Figure 45. In this way that surface of the body which lines the shell becomes converted into the two lobes of the mantle, and between them a mantle cavity is formed, into which the velum can be drawn when the animal is at rest. While these changes have been going on over the outer surface of the body, other important internal modifications have taken place. We left the digestive tract at the stage shown in Figure 36, without any communication with the exterior.

Soon the outer wall of the body becomes pushed inwards, to form the true mouth, at a point (Figure 37), which is

upon the ventral surface, and almost directly opposite the point where the primitive mouth was situated at an earlier stage. The digestive cavity now becomes greatly enlarged, and cilia make their appearance upon its walls, the mouth becomes connected with the chamber which is thus formed, and which becomes the stomach, and minute particles of food are drawn in by the cilia, and can now be seen inside the stomach, where the vibration of the cilia keep them in constant motion. Up to this time the animal has developed without growing, and at the stage shown in Figure 36 it is scarcely larger than the unfertilized egg, but it now begins to increase in size. The stages shown in Figures 44 and 45 agree pretty closely with the figures which European embryologists give of the oyster embryo at the time when it escapes from the mantle chamber of its parent. The American oyster reaches this stage in from twenty-four hours to six days after the egg is fertilized; the rate of development being determined mainly by the temperature of the water.

Soon after the mantle has become connected with the stomach, this becomes united to the body wall at another point a little behind the mantle, and a second opening, the *anus*, is formed. The tract which connects the anus with the stomach lengthens and forms the intestine, and, soon after, the sides of the stomach become folded off to form the two halves of the liver, as shown in Figure 44.

Various muscular fibres now make their appearance within the body, and the animal assumes the form shown in Figures 44 and 45.

All my attempts to get later stages than these failed, through my inability to find any way to change the water without losing the young oyster, and I am therefore unable to describe the manner in which the swimming embryo becomes converted into the adult, but I hope that this gap will be filled, either by future observations of my own or by those of some other embryologist.

In my attempt to raise the oyster embryo from the egg, I found that continuous warm weather was essential to success.

As my observations upon the developing eggs occupied all my time, I was not able to make any record of the temperature of the water of the ocean, but during June there were a number of cold, windy days and nights, and two hail-storms, and on each of the cold days all the embryo which I had in the house died.

Before I close this portion of my paper, I wish to call attention to some points of general interest, which have suggested themselves to me during the prosecution of my work.

At first sight it does not seem possible that an animal which is encased in a hard, strong, protecting shell, and which is capable of giving rise to several million eggs every season, can be in any danger of extermination; and it seems as if the oyster ought to be able to hold its own in the struggle for existence, and to increase and multiply in the face of the most adverse circumstances.

It appears wonderful that the waters of the Chesapeake Bay are not paved with oysters, and persons who have not given much thought to the subject will ridicule the statement that there is any need for measures to prevent their extermination or the destruction of the natural beds. While the consumption of oysters was restricted to regions in the immediate vicinity of the beds, the number of oysters which it would pay to gather and put into the market each season from each bed was limited; but with the present facilities for packing and transporting oysters, there is no limit to the number which can be utilized, and the danger of destroying the best beds grows greater every day, and keeps pace with the increasing population and improvements in transportation.

Those who believe that the abundance of the supply up to the present time is sufficient proof that it will continue, will do well to reflect upon the facts given in the following table, which I have condensed from a recent book on the oyster, by Möbius (Die Austern und die Austernwirtschaft, Möbius, Berlin, 1877, page 67.) He gives a long table, showing the number of oysters taken yearly from the Bay of Cancale, on the coast of Norway, for about one hundred years, and I have copied enough from it to show its character:

In the	year		1800	the	number of	oysters	taken	was	 1,200,000
"	"	"	1820	"	"	"	"	"	 6,000,000
"	"	"	1825	"	"	"	"	"	20,000,000
"	"	"	1830	"	"	"	"	"	36,000,000
"	"	"	1835	"	"	"	"	"	43,000,000
"	"	"	1840	"	"	"	"	"	52,000,000
"	"	"	1845	"	"	"	"	"	67,000,000
"	"	"	1847	"	"	"	"	"	71,000,000
"	"	"	1850	"	"	"	"	"	50,000,000
"	"	"	1855	"	"	"	"	"	20,000,000
"	"	"	1860	"	"	"	"	"	 8,000,000
"	"	"	1865	"	"	"	"	"	 1,100,000
"	"	"	1868	"	"	"	"	"	 1,079,000

Previous to the year 1800, and from this date to 1825, the number taken each year was small, and did not average more than five or six million oysters, and the enormous numbers which were taken from the beds in late years show that the removal of this moderate number yearly had no tendency to destroy the beds. It seems quite evident from the figures that the bed might have yielded twenty million oysters a year for an indefinite period, and the figures given for the years after 1825 are therefore highly instructive, for they show that a bed which is capable of furnishing a very great supply of oysters may be completely exterminated within a comparatively few years by unlimited dredging.

The table also shows that it will not answer to rely upon the very great number of eggs, and therefore trust to a few oysters the work of replenishing the bed.

In view of such facts, no one who appreciates the magnitude of the oyster industry of the Chesapeake can doubt that the protection of the natural oyster beds is a matter which is worthy of the most careful attention. While the manner in which this is to be accomplished is outside the scope of the present paper, a statement of those favorable and unfavorable influences which have suggested themselves to me during my work, may fairly find a place here.

It is well known to naturalists that the number of individuals which reach maturity in any species of animals or plants does not depend upon the number which are born. The

common tape-worm lays hundreds of millions of eggs in a very short time, yet it is comparatively rare. The number of children born to each pair of human beings during their life-time of from fifty to eighty years, can be counted on the fingers, yet man is the most abundant of the larger mammals, and human population increases quite rapidly under favorable circumstances. This comparison shows plainly that the abundance of a species is determined, mainly, by the external conditions to which it is exposed, and that the number of individuals which are born has very little to do with it. In the case of the oyster, the adult is well protected against enemies by the shell, and as its food is abundant, and is brought to it by the water, it is tolerably sure of a long life after it has reached its adult form, but the life of the young is very precarious; that of the young American oyster peculiarly so, since it is exposed to all kinds of enemies and accidents, at a time when it is most helpless. The protection of the young European oyster by the parent shell at this time would seem to more than balance the greater number of eggs laid by the American.

The most critical time in the life of the American oyster is undoubtedly the time when the egg is discharged into the water to be fertilized, for the chance that each egg which floats out into the ocean to shift for itself will immediately meet with a male cell is very slight, and it is essential that the egg should be fertilized very quickly, for the unfertilized egg is destroyed by the sea water in a very short time. The next period of great danger is the short time during which the embryos swarm to the surface of the water. They are so perfectly defenceless, and so crowded together close to the surface, that a small fish, swimming along with open mouth, might easily swallow in a few mouthfulls a number equal to the human population of Baltimore. They are also exposed to sudden changes of temperature, and as my experiments have shown that a sudden fall in temperature is fatal to them at this time, the number which are destroyed by cold rains and winds must be very great indeed.

As soon as they are safely past this stage, and scatter and

swim at various depths, their danger from accidents and enemies is greatly diminished, and their chance of reaching maturity increases hundreds, and probably thousands of times.

My experiments show that there is no difficulty in developing them up to this point in the house in small aquaria, and in carrying them safely past the most precarious part of their lives, and freeing them from all their greatest dangers.

Although the mortality at these early stages is so excessive, the number of young which pass through them safely without help is very great, and if there were no other dangers and uncertainties there would be no need of measures for their protection. As they swim to and fro in the water, they are carried to great distances by the tides and currents and reach all parts of the region of water in which the parent bed is situated. In a favorable year a floating plank or bush, or piece of drift-wood, will be found to become covered with small oysters which have fastened to it, although it may not be within miles of any natural oyster bank. The fact that the young may be collected in this way in any part of the Chesapeake Bay shows that the young oysters must settle down upon the bottom in nearly all parts of the bay, and we should expect the adults to have an equally general distribution. This is far from the case, and nothing could be farther from the truth than the idea that the bottom of the waters of the oyster regions is uniformly covered with oysters, and that it is only necessary to throw a dredge overboard and drag it along the bottom for a short distance, in order to bring it up full. Nothing could be a greater mistake, for both in this country and in Europe, the oysters are restricted to particular spots, "beds" or "banks," which are as well defined and almost as sharply limited as the tracts of wood-land in a farming country. These beds are so well marked that they can be laid down on a chart or staked out with buoys; and even in the best oyster regions they occupy such an inconsiderable part of the bottom that any one ignorant of their position would have very little chance of finding oysters by promiscuous dredging. Although the young are distributed every year, by the tides and currents, to all parts of the bottom, the dredge very seldom brings up even a single oyster outside the limits of the beds.

The restriction of the oysters to certain points does not appear to depend upon the supply of food, or upon the character of the water, but almost entirely upon the nature of the bottom. The full-grown oyster is able to live and flourish in soft mud, as long as it is not buried too deeply for the open edge of the shell to reach above the mud, and draw a constant supply of water and food onto the gills. The placing of adult oysters upon such bottoms at convenient points, to "fatten" for the market, is a well-known practice. The oyster embryo would be ingulfed and smothered at once if it should settle down upon such a bottom, and in order to have the least chance of survival and long life the young oyster must find some solid substance to fasten itself to, in order to preserve it from sinking in the soft mud or from being covered by shifting sand or gravel. As soon as the young oyster finds such a solid body, rough and clean, it fastens one valve of its shell to it by secreting a cement of shelly matter around the growing edge.

The living and dead shells of the adult oysters furnish the best surfaces for the attachment of the young, and for this reason the points where oyster beds are already established are those where the young have the most favorable surroundings and the best chance for life, and the beds thus tend to remain permanent and of substantially the same size and shape.

At the time of attachment the shell of the young oyster is still very thin and delicate, and the animal falls an easy victim to the numerous enemies which abound upon the oyster beds, such as crabs of various sorts, carnivorous gasteropods and various fishes.

It is not an uncommon thing for fifty or a hundred young "spat" to attach themselves to one full-grown shell. Some of these are killed by enemies, and others are crowded out, so that only a few grow up at the expense of the others, and the number which survive is astonishingly small. Möbius has made an attempt to ascertain what chance of survival the newly-hatched oyster has. The ratio between half-grown and adult oysters in the oyster beds of Schleswig-Holstein has

been ascertained and recorded, at intervals of a few years, for more than a century, by a systematic method of counting the contents of a certain number of sample dredgings. From a Danish book on the subject (Der Danske Osterbanker, by H. Kroyer, Kjöbenhaven, 1839), and from other sources, he obtains the following series of ratios:

In 1730	there	were	486	half-grown	oysters	to every	1,000	full-grown	ones.
" 1734	"	"	310	"	"	"	1,000	"	"
" 1740	"	"	418	"	"	"	1,000	"	"
" 1756	"	"	490	"	"	"	1,000	"	"
" 1775	"	"	484	"	"	"	1,000	"	"
" 1799	"	"	307	"	"	"	1,000	"	"
" 1819	"	"	388	"	"	"	1,000	"	"
" 1830	"	"	417	"	"	"	1,000	"	"
" 1839	"	"	440	"	"	"	1,000	"	"
" 1852	"	"	473	"	"	"	1,000	"	"

or an average of 421.2 to 1,000, or 42.13 per cent. of young. The uniformity of the ratio between the half-grown and the adult oysters, through a period of more than one hundred years, is very remarkable. In no case was there less than 30 per cent. of young or more than 50 per cent., and the average of 42 per cent. is very closely followed After an oyster has become half-grown its dangers are very few, and this number—42—probably gives with sufficient accuracy the number of oysters which grow up each year for each 100 adults. Although the number of young which are born each year is great beyond computation, those which survive are less than half as numerous as the adults.

Möbius has estimated the number of adults which spawn each year, and multiplying this number by the average number of eggs laid by each, and dividing by the number which grow up, he reaches the conclusion that each oyster which is born has $\frac{1}{1,145,000}$ of a chance of reaching maturity. In the case of the American oyster, the number of eggs is very much greater, and each one's chance of survival is accordingly very much less, and it is evident that the great fertility of the oyster will not protect a bed from destruction by excessive dredging, for while the young spat frequently cover the

shells of the adults by hundreds, the number of half-grown oysters is always less than one-half the number of adults. The great mortality of the young, after they have fastened themselves to the shells of the adults, is due in part to want of room, in part to the attacks of enemies, in part to accidents, such as the shifting of the bottom, and in part, no doubt, to lack of food. While the supply of organic matter which is carried to them by the water is very great, it is not unlimited, and the amount which each oyster can obtain at any one time is quite small, and if the oysters covered the bottom in sufficient abundance, some of them might fail to obtain a sufficient supply. I do not believe, however, that this ever occurs, for long before the oysters are sufficiently abundant to exhaust the supply of organic matter, their numbers are limited by other conditions. The growth of an animal does not depend upon the supply of food in general, but upon the supply of the least abundant of the necessary ingredients of the food. It is well known that a field that is very fertile will fail to produce a satisfactory crop of a plant which needs some particular food-ingredient which the soil contains in too small quantity. Although food in general is very abundant, the growth of this particular crop depends upon the amount of this ingredient, and while the seed which has been planted yields an abundant crop of young plants, only a few are able to grow up, and these can grow no faster than they can extract this particular ingredient from the soil.

In addition to organic food, the oyster needs a supply of carbonate of lime to make its shell, and this is supplied to it, in solution, in sea-water. If the shell is thin, or if it is formed very slowly, the danger from enemies and accidents is greatly increased; and those oysters which are able to construct their shells with the greatest rapidity are the ones which survive and grow up. The amount of dissolved carbonate of lime which the ocean contains is unlimited, but the amount which can reach each oyster is not very great; and if all the oysters which attach themselves were to survive there can be no doubt that they would exhaust the available supply of lime before they failed to obtain enough organic food.

It is well known that shell-fish of all kinds thrive best when the supply of lime is greatest. The fresh-water mussels which live in streams and ponds where the supply of lime is scanty, grow slowly, and their shells are so thin that they are very subject to accidents, and their numbers are limited; but in limestone regions the shells are large and heavy, and the bottoms of the streams are almost paved with mussels, and it is well known to conchologists that coral reefs and islands are the most favorable regions for the abundant growth of all kinds of shelled molluscs.

The dead oyster-shell is soon corroded, and in a few years entirely dissolved, by the sea-water; and I think this fact is another reason why the young oysters thrive best on a natural oyster-bed.

How far the supply of oysters is limited by the supply of lime it is impossible to say; but when we recollect how important it is that the young oysters should soon find solid bodies to fasten themselves to, and that they should protect themselves by strong shells of their own as quickly as possible, it will be seen that the danger of exterminating a natural bed by over-dredging would be much less if the empty shells were replaced upon the bed. There can be no doubt that the best natural beds may be destroyed by over-dredging, and that this fate will be certain to overtake the beds of the Chesapeake Bay if the oyster industry continues to increase, and matters are left to adjust themselves.

Like most dangers, this is one which will not become conspicuous until it is too late to find a simple remedy.

Whether the number of oysters which are at present taken from our oyster beds is too great or not is a matter which is outside the field which I undertook to investigate, but it is a matter in which the public have the greatest interest, and the extent of the oyster beds, and the number of oysters which they can supply each year, should be accurately ascertained before it is too late.

A prophet of future evil is always regarded as an unseasonable croaker, but the facts which I have noticed seem to show that, whether the danger of exterminating the best and most

accessible oyster beds is near or remote, it is sure to force itself upon us some time. If we wait for that time the remedy will be slow and expensive, but prevention of the danger in time would not necessarily be attended with any very great expense.

The investigation into the hydrography and general condition of the oyster beds of Tangier and Pokamoke Sounds, which has been so ably conducted by Captain Winslow, of the United States Coast Survey, during the past two summers, will supply the necessary information; and should these investigations show that any of these beds are in immediate need of artificial help to save them from destruction, I hope that the observations I have detailed in this paper may point to the way in which this help may be given.

PART II—EMBRYOLOGY.

THE SEXES OF THE OYSTER.

A list of the contradictory opinions which various writers have expressed regarding the distinctness of the sexes of the oyster is hardly worth publishing, since all the thoroughly competent observers who have investigated the subject in modern times agree that each oyster is, at the breeding season, either a male or a female.

During my investigations I submitted more than a thousand oysters to microscopic examination. My studies were carried on during the breeding season, and I did not find a single hermaphrodite. The male cells are so small compared with the eggs that it would be impossible to state that a mass of eggs taken from the ovary contained no spermatozoa, although they could not escape detection if they were at all abundant.

On the other hand, a single egg in the field of the microscope in a drop of male fluid would be very conspicuous, and could not escape detection; and the fact that not a single case of this kind occurred is sufficient to establish the distinctness of the sexes at the breeding season.

A short time since, October 25th, I examined a number of oysters with the same result. I found six females with ovaries filled with nearly ripe ovarian eggs, and eight males whose testes were filled with spermatozoa, most of which were immature, but some of them fully developed and active.

One of the males and one female were hardened in chromic acid, and a number of microscopic sections were cut from various parts of the reproductive organs of each. None of the ovarian follicles or parts of follicles of the female contained anything but eggs, and not a single egg at any stage of development was found in any part of the body of the male.

In order to show how conspicuously the characteristics of the sexes are shown in these sections I have made careful drawings of two of them. Figure 53 is a section of part of the visceral mass of the female, showing nine ovarian follicles cut in various directions. Each follicle contains a nearly central cavity, and around this, on all sides, the opaque granular eggs project from the basement membrane of the follicle, to which they are attached either directly or by long stalks. Each egg contains a large, conspicuous, oval, transparent nucleus, and a single nucleolus, which is on that side of the nucleus which is nearest the point of attachment to the membrane. The eggs are so crowded that they are flattened and rendered polygonal by mutual pressure, and in some places there is a very regular alternation of those with and those without stalks.

Figure 67 is a section of a portion of the visceral mass of a male, as seen with the same magnifying power. The space nearest the basement membrane of each follicle is here occupied by a thick layer of small cells, the mother cells of the spermatozoa, and the centre of the follicle, instead of being empty, as in the female, is filled with a mass of spermatozoa, which have been set free. Some of the follicles shown in this section open by slightly constricted orifices into a large oval duct, with a lining of epithelial cells. These ducts are filled with nearly ripe spermatozoa, which have been forced into them from the follicles, and even in the hardened specimen traces of the movement of the spermatozoa from the cavities of the follicles into that of the duct are retained. A comparison of this figure with the one just described shows the male follicle to be so different from the female follicle in structure and appearance that the occurrence of a male follicle in a section of the ovary, or of a female follicle in a section of the testis, could not escape instant detection, and it is also plain that one of the very characteristic ovarian eggs shown in Figure 53, could hardly fail to attract attention at once if it should occur in a section of the testis.

My observations tend to show, then, that the sexes are separate in the American oyster of the Chesapeake Bay during

the summer months and up to the end of October, but the present season has been unusually mild, and Capt. Winslow, U. S. N., tells me that he found oysters in October of this year in Tangier Sound, the eggs from which he succeeded in fertilizing. It is possible, then, that those which I examined were ready to spawn this season. If this is so, all my observations have been made during the breeding season, and it may be possible that later in the year hermaphrodite individuals may be found. There is nothing improbable in the statement that oysters change their sex, and that an individual may be a female one year and a male another year, but my observations certainly do not indicate that this is the case with the American species.

The only observations which I have met with on this subject, made in this country, are by McCrady (Observations on the Food and Reproductive Organs of Ostrea Virginiana, with some Account of Bucephalus Cuculus: Proceedings Boston Soc. Nat. Hist., December 3d, 1873, pp. 170–192). He says that at a time when the ovarian eggs are very small and immature "the spermatozoa may be seen in their aggregated or even their free condition, actively moving about among masses of granular yolk substance, inclosing many germinative vesicles, without exhibiting any attraction for them, and without the appearance of any change in the young vesicles themselves." (Page 172.)

Regarding the oysters nearer the breeding season, when the eggs were more mature, he says, p. 174: "I endeavored next to ascertain whether or not spermatozoa were present, but could not satisfy myself on this point, as my eye had become fatigued, and no disposition of the light enabled me to discover whether the minute dancing cellules, which were quite numerous, had or had not a tail."

This observation would seem to indicate that, while the sexual elements are immature, both male and female elements may occur in the same individual.

The most thorough and satisfactory observations upon the sex of the European oyster are those by Möbius, and his account shows that the sexes are separate at the breeding

season. His observations were published in 1871, under the title "Untersuchungen über die Fortpflanzungsverhältnisse der Schleswigschen Austern. Nachr. der deutchen Malak. Gesellsch. III, 1871. Abstr. in Hoffmann u. Schwallbe's Jahresberichte, 2, 1873, p. 338. In his most recent publication on the oyster (Der Auster und die Austern-wirtschaft, Berlin, 1877), he reviews the subject and says, p. 19: "Die Austern sind Zwitter. In einer grösseren Zahl Austern fande ich in der ganzen Geschlechtsdrüse nur Befruchtungskörper, aber keine eier. Bei 7 Austern, die blau Brut im Barte trugen enthielt die Geschlechtsdrüse Befruchtungskörper."

It would seem to be at least as probable that these seven oysters were males which had drawn floating embryos in onto their gills as that they were females which had changed to males after laying all their eggs.

"Drei Austern mit jüngeren weissen Keimen im Barte hatten keine Befruchtungskörper in der Geschlechtsdrüse. Bei den meistern Keimenträchtigen Austern enthielten der Geschlechtsdrüse weder Eier noch Befruchtungskörper. Von 309 Austern, welche am 25 Mai auf vier verschiedenen Bänker im Osten der Insel Sylt gefischt und von 26 Mai bis 1 Juni untersucht wurden, waren 18 Procent geschlechtlich unentschieden, dei übrigen 82 Procent waren zur Hälfte eierträchtig, zur Hälfte spermaträchtig. Bie keiner waren die Geschlechtsproducte ausgereift. Aus diesen Befunden schliesse ich dass in der Geschlechtsdrüse der Austern nicht gleichzeitig, sondern folgzeitig Eier und Befruchtungskörper entstehen; dass Befruchtungsköper sehr bald nach dem Ausstossen der Eier entstehen können, und dass wahrscheinlich der eine Hälfte der Austern einer Gebietes in einer Brutperiod blos Eier die andere Hälfte blos Sperma bildet."

His conclusion that the sex of the oyster changes after the reproductive elements have been discharged from the body, is thus seen to rest upon the occurrence of spermatozoa in the reproductive organs of oysters whose gills carried embryos, but as it seems perfectly possible that these might have escaped from the mantle chambers of the oysters, and thus gained access to the gills, there is no proof that these oysters had ever acted as females.

Lacaze-Duthier's observations, published more than twenty years ago (Ann. d. Sc. Nat. 1854. Organes génitaux des Acéphales Lamellibranches.; and, Comptes rendus, 1855, x 4, 415–420. Des organes de la generation de l'huitre), are very similar to those of Möbius. He says that at any given time each oyster is almost exclusively male or almost exclusively female, and he thinks that the young oysters are functionally male, and become female as they grow older.

As I have already stated, I have found oysters only one year old which contained ripe eggs, and eggs only, and others of the same age which were exclusively male, and I have succeeded in fertilizing the eggs of the one with the fluid of the other. This observation, which is corroborated by Gerbe's statement (Zool. Record, 1876, xiii., Mol. p. 62), that among 435 European oysters one year old, he found 35 with young; 127 with ripe eggs, and 189 with ripe semen, seems to be sufficient to show the incorrectness of Lacaze-Duthier's conjecture that the functionally male condition precedes the functionally female condition.

MANNER OF FERTILIZATION.

Although the American oyster seems well adapted, like the European species, and various other marine and fresh-water Lamellibranchs, to draw into its mantle-chamber, with the sea-water, the spermatozoa discharged from the mantle-chambers of neighboring oysters, and thus to bring about the fertilization of the eggs inside the cavity of the shell, this does not seem to occur.

I have carefully searched the gills and mantles of more than a thousand oysters at a time when the reproductive organs were plainly seen to be discharging their ripe contents, and have not found a single fertilized egg or embryo in any part of the mantle-chamber, in or on the gills, or anywhere else inside the shell. This negative evidence, together with the fact that the eggs can be hatched after they have been artificially removed from the ovaries seems sufficient to prove, in the absence of all evidence to the contrary, that the eggs of the American oyster undergo development in the open ocean.

The various observations which have been published regarding the place where the eggs are fertilized in the European oyster are very contradictory.

In 1827 Home stated (Phil. Trans. 1827,) that the eggs are impregnated inside the ovaries; but as his paper also states that the rotation of the ciliated embryo is caused by a parasitic worm, it is doubtful whether the means at his command were adequate to the solution of the question.

In the "Report of the Commission appointed to Examine into the Methods of Oyster Culture in France and in the United Kingdom with a view to the Introduction of Improved Methods of Culture of the Oyster into Ireland, 1870," J. G. Hart, Esq., one of the Commissioners, says, p. 10: "Artificial fecundation, such as is practiced with the Salmonidae, is impossible, from the fact that fecundation takes place before the extrusion of the ova from the ovaries, and therefore we must conclude that with the oyster the utmost that can be done by so-called artificial breeding is not the procuring of artificial impregnation, but only the shepherding of the impregnated ova during infancy." The five original figures which he gives, pp. 9 and 11, Figs. 1, 2, 3, 4 and 5, as well as his account of the early stages of the oyster, are so crude and indefinite as to throw great doubt on the value of his evidence.

In a work entitled "Guide Practique de l'Ostreicultur," Prof. Felix Fraiche makes a similar statement, that since the eggs are fertilized within the ovaries artificial fertilization is impossible, but his statement does not appear to be based upon observation.

Eyton, who appears to be a thoroughly competent observer, states (History of the Oyster and Oyster Fisheries, by T. C. Eyton, F. L. S., F. Z. S.: London, 1858, p. 21) that in a number of oysters which he has opened and examined at various times, and from different places, embryos, at different stages of development, were present inside the ovaries as well as on the gills. There seems to be no reason for doubting his evidence, but it does not seem to be sufficient to show that the eggs are fertilized exclusively in the ovaries.

Möbius, whose statements rest on careful observation, states

(Die Austern und die Austern-wirtschaft, p. 17) that the oysters discharge their ripe eggs into the gills, and that they commence their development after they have left the reproductive organs

The occurrence of unfertilized eggs on the gills is conclusive evidence that impregnation does not always take place in the ovaries, but it cannot be regarded as evidence that the eggs have not been discharged from the cloaca into the external water, and then drawn back into the mantle chamber. It seems possible that some, at least, of the eggs of the European oyster may be fertilized outside the shell, as is the case with the American species; but there does not at present seem to be any reason to believe that they ever complete their development elsewhere than inside the shell. It is, of course, impossible for an American to decide this point, but I think it is one to which the renewed attention of European naturalists might well be directed.

SEGMENTATION.

The segmentation of the oyster egg is remarkable for its great rapidity, for its bilateral symmetry, and for the very well marked alternation of periods of activity with periods of rest. The rate of segmentation varies greatly according to temperature and other conditions, but in some cases the ciliated embryo is formed within two hours after fertilization. After the completion of the first division the position of the right and left sides, as well as that of the dorsal and ventral surfaces, is determined.

The ripe, unfertilized egg is quite variable and irregular in shape, usually elongated and pear-shaped, but sometimes polyhedral, and without the stalk, round over part of its surface and flattened over part, or even perfectly spherical. The characteristic shapes of the eggs are well shown in 49, 51 and 53. No external membrane is visible in the unfertilized egg, and, as shown in the figures, the protoplasm of the yolk forms a thin, slightly granular layer around the very large oval, transparent germinative vesicle, which again contains a single, more highly refractive, germinative dot. In

from five minutes to an hour after impregnation the egg becomes quite regularly spherical, as shown in Figure 1, and is now covered by a distinct limiting membrane, which adheres closely to the surface of the uniformly granular yolk.

The changes of segmentation take place so very rapidly that the close observation of the living egg demanded all my attention, and I was not able to make any observations upon stained specimens, regarding the fate of the germinative vesicle, or the orgin of the polar globules or formation of the first segmentation nucleus; and the living egg is sufficiently opaque to prevent observations upon this point.

After the egg has assumed the spherical form shown in Figure 1, it remains without change for some time, usually nearly an hour, and then enters upon a period of activity, during which changes follow each other with great rapidity.

The first thirteen figures were drawn from the same egg. As the day was very cold, the changes were slow, and the first period of activity did not set in until two hours and seven minutes after impregnation, but the series of changes shown in Figures 2–13 occupied only seventeen minutes, and this was so much longer than usual that I was able to commence my series of drawings by sketching them.

As shown in Figure 2, the egg commences its activity by elongating and becoming oval, with one end narrower than the other. The narrow end is to become the nutritive pole, and the broad end the formative pole of the segmenting egg. In all the figures of segmenting eggs the formative pole is above, and the nutritive below, and the latter corresponds, in a general way, to the dorsal surface of the embryo.

Contractions now begin to make their appearance at the formative end, throwing the limiting membrane into waves or wrinkles, which travel rapidly towards the formative pole, near which they disappear.

The wrinkles are shown in Figure 2. It is, of course, impossible to show their movement in a drawing, but the progression over the surface of the yolk, from the starting-point at the small end to the place where they disappear near the round end, is well marked, and is a constant characteristic,

which may be found in every egg by patient watching. It is of very short duration, and the limiting membrane usually becomes smooth again in about fifteen seconds after the contractions commence. Before I discovered that similar waves run over the surface of the egg for a few seconds at the beginning of the active changes at later stages of segmentation, I naturally inferred that they were connected with the extrusion of the polar globules. While it seems probable that they are in some way connected with this extrusion, their occurrence at later stages shows that this is not their only significance.

So far as I am aware, this is the first notice of their occurrence.

Soon after the waves commence, an area, which is a little less granular than the mass of the egg, becomes visible at the formative pole, and from this the first polar globule soon begins to protrude, pushing out the external egg-membrane. Figure 3 is the same egg two minutes later, and Figure 4 is the same after another interval of two minutes. The oval outline is now gradually changing to a pear-shape, the stalk of the pear occupying the nutritive pole, and the polar globule projecting from the middle of the broad end of the pear at the formative pole. During these stages the granular matter of the yolk may be seen to flow in a steady, slow current, around the periphery of the egg, but, as far as I could observe, the current has no definite starting-point or terminus. At these stages there are no waves on the surface, and the membrane is smooth. It is interesting to observe that while these changes are taking place the nutritive end of the egg grows a little more transparent than the formative end, a reversal of what occurs in almost all other eggs which pass through unequal or irregular segmentation, although Lovén has described the same phenomenon in Crenella. In a short time three planes of cleavage run in towards the centre of the egg from three equidistant points on the periphery, as shown in Figure 5, which is two minutes later than Figure 4, although the changes usually take place much more rapidly.

One of these planes is at the point occupied by the polar globule, and the others about midway between it and the

nutritive pole, and two of the three nearly equal masses into which the egg is blocked out lie at the formative end, and one at the nutritive end; the latter is less granular than the pear. The three furrows do not tend to meet exactly at the centre, but as shown in Figure 6, two minutes later than Figure 5, the one which runs down from the polar globule inclines to one side so as to meet one of the side furrows before the other. During the stages shown in this and the preceding and succeeding figures the protoplasm of the whole egg is violently disturbed, and the granular matter quivers or dances, with what would be called "Brownian" motion, were it not confined to this particular stage of development. At the stage shown in Figure 5, the three lobes *a*, *b* and *c* of the trefoil are nearly equal in size, but at the present stage, Figure 6, the one at the nutritive end, *a*, is the largest, and the one which is most perfectly separated, *c*, the smallest. The later stages show that this smallest spherule is posterior to the larger one, and this figure therefore gives a view of the left side of the egg or embryo with its dorsal surface below. For the sake of brevity, we may now call the smallest spherule, *c*, of Figure 6, the first micromere, the next largest, *b*, the second micromere, and the one at the nutritive pole, *a*, the macromere.

In one minute after the stage shown in Figure 6 the vertical furrow has united with one of the lateral furrows, to separate off the first micromere, and the second lateral furrow has run in and united with the line thus formed, so that the egg is now divided into three separate masses, each of which now becomes spherical, as shown in Figure 7. This stage ends the first period of activity, and the changes which follow result in the gradual obliteration of the sharply defined characteristics which have been acquired.

In forty-five seconds after the stage shown in Figure 7 the two micromeres, *b* and *c*, have approached and united with each other, as shown in Figure 8, and the second micromere, *b*, has also become fused with the macromere, *a*, although the egg still has its trefoil outline, and is now very similar to the stage shown in Figure 5. In another minute Figure 9, the fusion of the second micromere, *b*, with the macromere, *a*, is

much more marked, and the first micromere *c* has also begun to unite with the macromere. Up to this time the lines of union of the three spherules have been visible, but in another minute, Figure 10, there is no line to indicate the fusion of the second micromere *b* with the macromere *a*, and the primitive distinctness of the two is only indicated by a depression in the outline, which soon disappears entirely, as is shown in Figures 11 and 12. At the same time the first micromere, *c*, becomes more completely united to the mass, *a* and *b*, formed by the fusion of the second with the macromere, although, as shown in Figures 11, 12, 13, 14 and 15, the line of separation never becomes invisible, Of these, Figure 11 is three minutes later than Figure 10, and Figure 12 two and three-quarters minutes later than that. The next figure, 13, is from another egg, but is about two minutes later than 11, and shows the characteristics at the end of the second period of rest. At some time during the stages of which I have been speaking the egg sheds an external membrane, and I have copied this drawing here in order to show the membrane, nearly cast off. It will be seen that the casting of this membrane does not leave the surface of the yolk exposed, but that it is still covered with an investing membrane. I am unable to say whether the membrane was originally more than one layer thick, or whether a new one is formed to replace the one which is shed. The time when the egg escapes from this membrane varies greatly, but it is usually earlier than this stage, and an egg at the stage 10, in the act of escaping, is shown in Figure 46. At the stage 13 the egg is again almost spherical, and consists of two masses, a large one, *a* and *b*, and a small one, *c*, meeting each other upon a flat surface. The preceding stages show that the larger mass is compound, and made up of the macromere and second micromere, but there is no visible indication of this fact. The long axis of the egg, at this stage, does not pass through the polar globule, but parallel to it.

At the stage which corresponds to this the eggs of many molluscs have a segmentation cavity, but there does not seem to be any space between the two spherules of the oyster-egg,

nor does a segmentative cavity make its appearance until much later.

From the stage shown in Figure 1, up to the stage shown in Figure 10, no traces of a segmentation nucleus could be made out in the living egg, but at the stage shown in Figure 11, a large, circular, transparent body appears in the first micromere and another at the formative end of the compound mass formed by the fusion of the second micromere with the macromere.

At the end of the second period of rest (Figure 13), these bodies are much larger, and their outlines are very clear. The commencement of the second period of activity is shown in Figure 14, which is six minutes after Figure 13. The two spherules swell up and become much more conspicuous than they were at the stage before, although they are still in contact over a considerable area. The wave-like motion, noticed at an earlier stage, is now repeated in each spherule, and runs over the surface from the point furthest from the polar globlue towards the end where this is situated; the wave continuing for about half a minute. At the time this motion commences a remarkable change takes place in the two transparent vesicles already mentioned. Each of these becomes irregular and star-shaped, and long channels radiate from it into the substance of the yolk, as shown in Figure 47. The central chamber then instantly disappears; the radiating channels are visible for a fraction of a second longer, and then disappear, and the places which the two large chambers had occupied are now (Figure 14), seen to be occupied by two small refractive nuclei. I at first thought that the radiating channels might be the same as the star-shaped figures of recent embryologists, but it seems more probable that each of the large chambers of Figures 11, 12 and 13, contains a nucleus which might be brought out by reagents, and which is surrounded by a more fluid substance, the diffusion of which through the yolk precedes the formation of the amphiaster and the division of the nucleus. It is possible that this diffusion is the cause of the peculiar star-like arrangement of the granules of the yolk around the nu-

cleus. The disappearance of the large chamber by a sudden contraction, and the diffusion of its contents through radiating channels, are phenomena which are as unmistakable as the somewhat similar changes of the contractile vacuole of an infusorian, although, like the latter, they are somewhat difficult to discover, and can only be seen by keeping the egg under constant observation.

In some instances, I was able to actually observe the disappearance of the germinative vesicle of the oyster egg. In many Lamellibranchs this body has considerable elasticity, and in Anodonta it may be forced by pressure through a small fissure in the ruptured egg-shell, and it will regain its original shape and size after it has escaped from the egg. This is not the case in the oyster, and in the ripe egg the vesicle seems to be almost as fluid as water, and cannot be pressed out of the yolk. Like all the changes in the oyster egg, the disappearance of the germinative vesicle takes place with great rapidity, and the manner of disappearance is identical with that which I have just described in the case of the segmentation nucleus. It becomes irregular; radiating channels run off from it into the yolk; the central chamber vanishes, and the channels are visible for an instant longer, and then disappear. The yolk is so opaque that I was not able to see that any part of the vesicle was left behind as a pronucleus, but this is probably the case.

It is useless to speculate at present upon the significance of these highly suggestive changes, but they certainly show that we may hope for very interesting results from the minute histological study of the eggs of marine Lamellibranchs.

In this connection, I may call attention to a point in the history of the "Auerbach's figures." It is not generaly known that these were first figured by Carus, more than fifty years ago, in the egg of a Lamellibranch. His figures of the segmenting egg of Unio (Neue Untersuchungen über die Entwickelungsgeschichte unserer Flussmuschel. Von Dr. J. G. Carus. Nova Acta, 1832, 8, 1), show these structures about as they are represented by Flemming, but he regards them

as the plates of a calcareous shell, and compares the egg to a sea-urchin.

To return to the segmentation; immediately after the large vesicles have disappeared, the egg has the appearance shown in Figure 14. One minute later (Figure 15), the first micromere, *c*, has become nearly spherical, and stands out sharply from the remainder of the egg, and the compound mass, *a* and *b*, of the preceding figures, is again separated into the macromere, *a*, and the second micromere, *b*. In another minute (Figure 16), the formative pole is divided into four micromeres, one of which, *b*, is only slightly marked off from the macromere, while the three others are more distinct. The impossibility of seeing both sides of the egg at once makes it difficult to say just how these four spherules are formed, but it seems most probable that two of them are formed by the division of the first micromere, and two by the division of the second.

In the egg which was figured the nearest spherule bears every indication of an origin by the division of the first micromere, *c*, into two, and other eggs served to show with equal clearness that one of them is also separated off from the second micromere, *b*. Certain irregular forms of segmentation, which will be described later, also appear to sustain this view.

Owing to an unfortunate oversight, the dotted lines which should connect the letters of reference with the parts they refer to were not copied in the drawings from which the photo-electrotypes of Plates II. and III. were made; but I hope that a more careful description will supply a remedy for the accident. Two minutes later, Figure 17, three of the micromeres, the first, *c*, and the two new ones, *d d*, are well defined and prominent; but one of them, the second micromere, *b*, has again begun to become fused with the macromere, *a*. After another interval of three minutes and a half, Figure 18, this micromere has become completely fused with the macromere, to form a compound mass, *a* and *b*, which is almost spherical, and in this a single transparent vesicle has made its appearance. The other three micromeres are even more

sharply separated than at the preceding stage, and a vesicle has made its appearance in each. After two minutes and a half, 19, these three micromeres have flattened down against each other and against the compound mass, so that the egg is once more nearly spherical. This stage may be called the third period of rest.

This figure and the one before it are from the same egg, as indeed are all the figures on this plate except 25, 27 and 28; but after Figure 18 had been sketched, the egg rotated a little, and Figure 19 is a view at right angles to all the preceding ones.

The vesicles are seen to be a little larger than they were a few minutes before, but I did not succeed in seeing them disappear at this stage.

The egg which was figured remained in the condition shown in Figure 19 for thirteen minutes, and during this time it rotated back again into the position which it had occupied at first.

At the end of thirteen minutes the three micromeres *c*, *d*, *d*, again became conspicuous; the compound mass, *a* and *b*, elongated, and a surface depression separated the portion *b* from the portion *a*, and the first micromere, *a*, quickly divided into two, as shown in Figure 20.

By moving the cover-glass, I managed to rotate the eggs a little, and to get a sketch, Figure 21, in the same position as Figure 19. Figure 21 is one minute later than Figure 20, and it will be seen that the second micromere, *b*, and two of the others, have already begun to flatten down and to pass into the resting condition.

From this time on I was not able to keep the egg under constant observation, but examined it at short intervals. A well marked resting period follows the stage shown in Figure 21, but as it presents no new features, it was not figured. Figure 22 is fifteen minutes later, and shows the egg at the fourth period of activity. There are now two more micromeres, which appear to be formed by the two, *c c*, Figure 20, which were produced during the third period of activity by the division of the first, Figure 14, *c*.

The egg is now made up of one large micromere, *a*, at the nutritive pole, and at the formative pole six small, distinct spherules, *ec*, on one side of the polar globule, and one large one, *b*, on the other side; this is flattened, in contact over a large area with the macromere, and is, without doubt, the second micomere of earlier stages.

The history of the later stages shows that the single micromere, *b*, of this stage is anterior to the polar globule, while the group of six is posterior to it. The single macromere occupies what is to become the dorsal surface, and this figure is accordingly a view of the left side. For the sake of brevity, I shall in future use the terms dorsal and ventral, right and left, and anterior and posterior in describing the embryo, and it will be convenient to make this figure a reference mark. The ventral surface is here above, the dorsal below, the left side towards the observer, and the anterior end on the right side of the figure.

Figure 23 is a view of the posterior surface of the same egg twenty-three minutes later. The micromeres which are posterior to the polar globule have now increased in number, and form a cap—the ectoderm—resting upon the macromere. The number of spherules, or ectoderm cells which form this layer, now increases rapidly by the division of large cells into smaller ones, and two couples which have been formed in this way are shown in the figure. The ectoderm is also increased by the separation of new spherules or micromeres from the macromere at the point where this touches the posterior border of the ectoderm. This portion of the ectoderm may therefore be called the growing edge.

Figure 24 is a view of the left side of the same egg five hours and fifteen minutes later. The anterior margin of the macromere is still separated from the polar globule by a single spherule, the second micromere, *b*, but posteriorly and at the sides the layer of ectoderm has grown considerably. At five points on the exposed side there are pairs of small cells, each of which has been formed by the division of a larger one. Figure 25 is another egg in nearly the same stage of development, but it has been copied here in order to show

the separation of a new micromere, *g*, from the macromere, *a*, at the growing edge of the ectoderm.

Figure 26 is a view of the same egg as Figures 22, 23 and 24, but fifty-five minutes later than Figure 24. The ectoderm cells are now much smaller and more numerous, and the macromere is almost covered by them. At the growing edge *g*, a new micromere is separating from the macromere, and there are now a number of small cells on the median line anterior to the polar globule. In dead eggs at this stage a transparent cavity separated the inner surface of the layer of ectoderm from the macromere, but this space does not appear to be normal, and the macromere seems, in living eggs, to be in contact with the outer layer, and there is no indication of a segmentation cavity. In many respects the segmentation of the oyster egg is very similar to that of the egg of Unio, as described by Rabl, but in Unio the segmentation cavity is present at a much earlier stage than this.

From this point on I made no attempt to trace the changes of individual eggs, but made sketches of new stages as I found them. The stages which are figured here are by no means all which were observed and sketched; and I found a number of embryos intermediate between nearly all the stages which were reproduced, so that my series was much more complete than the series of figures.

Figure 27 is a surface view of the left side of an embryo twenty-seven hours after impregnation, and Figure 28 is an optical section of the same embryo. The outline of the body has undergone considerable change, and the longest axis is now the axis which runs from the polar globule to the posterior end, and the vertical axis, which was the longest during the earlier stages, is now the shortest. In a view from above or below the outline is elliptical. The optical section, Figure 28, shows that the macromere is now divided into two large spherules, *en*, which are almost entirely covered by the ectoderm, *e c*, except over a small area on the dorsal surface. The polar globule is now separated from the anterior edge of the ectoderm by four cells, which are smaller than those at the opposite or growing edge. Figure 29, is a view of the

dorsal surface or nutritive pole of a somewhat older egg, showing the two spherules of the endoderm uncovered by the ectoderm. The flattening of the embryo at the ends of the vertical axis, which had made its appearance at the stage shown in Figure 27, has now become more pronounced, and the body is nearly disk-shaped, with its dorsal and ventral surfaces flattened and parallel. The two endoderm cells now divide up, and a short time after the stage last figured they are six in number, as shown in Figure 30, which is a view of the ventral surface; the dark endoderm cells being visible through the more transparent ectoderm. Figure 31 is an optical longitudinal section of a somewhat older embryo, represented with its dorsal surface to the right, and its anterior end above. The flattening of the upper and lower surfaces is well shown in this figure. At about this stage, or a little earlier, the ectoderm and endoderm separate from each other, and a well marked segmentation cavity, or, more properly, a body cavity, is now clearly visible between them. The endoderm has now divided up into a number of large spherules, forming a layer which is pushed in towards the ectoderm, so that the dorsal surface is no longer flat, but saucer-shaped, thus forming a wide, shallow cavity, the primitive digestive cavity, *g*. On the ventral surface the ectoderm cells now carry a few short scattered cilia, and the embryo begins to swim or rotate a little.

It now undergoes considerable change of form, and in a few hours it presents, when seen in a side view, the form shown in Figure 32.

This is a surface view of the left side, and Figure 33 is an optical longitudinal section of the same embryo. This stage is of great importance in the attempt to raise the young from artificially fertilized eggs, for the velum now makes its appearance, and the embryos swim to the surface of the water, where they form a dense layer, which can be siphoned off into a supply of pure sea water, leaving the dead eggs behind. The outline at this stage is very irregular, but perfectly definite and characteristic, although the great activity of the em-

bryo renders this, in the oyster, as in most other molluscs, the most difficult stage to study.

I give three surface views of it (Figures 32, 34 and 35), in order to show the characteristics of the various aspects. Figure 32 is a view of the left side, with the anterior end to the right and the dorsal surface below. Figure 34 is an anterior view of the ventral surface, that is, a view of the upper right hand surface of Figure 32, and Figure 35 is a view of the dorsal surface. In both 34 and 35 the anterior end is below. In the embryo from which these figures were drawn the polar globule was not present, but in other embryos it occupied the centre of the tuft of cilia of the velum, as shown, at a later stage, in 36, so that there can be no doubt that the velum occupies that end of the embryo which is above in Figure 31, and at the right in most of the preceding figures.

Near the centre of the ventral surface—the top of Figure 32—there is a well marked and constant protuberance of the body wall, which occupies the region which, in most molluscan embryos, gives rise to the foot, and which may perhaps be regarded as a rudiment of that organ. In front of this protuberance the anterior end of the body is round, and is occupied by the long cilia of the velum, which form a complete closed circlet. In the centre of the dorsal surface the body is crossed by a deep crescent-shaped furrow, 32, 34 and 35 *g*, which is transverse to the long axis of the body, and which is seen in an optical section, 33 *g*, to be prolonged into the body as the primitive digestive cavity.

Posterior to this the body terminates in a pointed protuberance, 32, 33 and 35 *a*, which is of importance in determining the relation between this and later stages, and which may be called the anal papilla. A comparison of Figure 33 with Figure 31 indicates that the present form of the body has been brought about by the infolding of the edges of the disk-shaped embryo, Figure 30, towards the dorsal surface, in such a way as to carry the endoderm into the centre of the body, thus giving rise to a primitive digestive cavity, with a dorsal blastopore situated in the centre of a crescent-shaped transverse furrow. Rabl has figured a stage in the develop-

ment of Unio (Entwickelungsgeschichte der Malermuschel, Figures 28 to 32), which is very similar to this, both in outline and in internal structure, and Flemming has figured a very similar stage in Anodonta (Entwickelungsgeschichte der Najaden, Taf. II Figure 32), but each of these authors regards the surface where the polar globule is placed as posterior. The published accounts of the transformation of the glochidium into the adult Unio or Anodonta (Ueber die postembryonale Entwickelung unserer Süsswassermuscheln (Anodonta). von Dr. M. Braun in Würzburg. and: Zur Entwickelungsgeschichte der Teich- und Flussmuschel. von Carl Schierholz.) are not sufficiently explicit to decide what the relation between the body of the larva and that of the adult really is, and until some one publishes a satisfactory illustrated account of the transformation, the fact that the velum of the oyster certainly makes its appearance at the point which is occupied by the polar globule must lead us to believe that Flemming and Rabl are in error, and that the region between the letters *a* and *i* of Rabl's Figure 28, is that which is occupied by the velum in the the marine Lamellibranchs, and therefore the anterior.

The free-swimming stage may be reached, under exceptionally favorable circumstances, within two hours after impregnation, but it is not usual for the embryo to attain to this degree of development in less than twenty-four hours, and it may require more than two days to reach it. The duration of this stage also varies greatly, but after from one to twelve hours the embryo will be found to have assumed the form shown in Figure 36, which is the same view as Figure 32. The outline of the body has not undergone much change, and the anterior end is still rounded and carries the velum, while the pointed anal papilla, *a*, occupies the posterior end. The foot-like protuberance on the ventral surface has disappeared, and the blastopore on the dorsal surface has entirely closed, and the ectoderm has become continuous over it, thus leaving the endoderm as a spherical body of cells inside the body cavity. I was not able to discover any central cavity inside this mass, but the cells are so opaque that it would be very difficult to

see a small cavity if one were present, and I do not think there is any reason to believe that the primitive digestive cavity becomes obliterated, although I am certain that this is the fate of its external opening. Before the crescent-shaped transverse groove has entirely disappeared, a small, irregular, transparent body, Figure 36 *s*, makes its appearance at each end of it, and the subsequent history shows that these two bodies are the two valves of the shell, which are entirely separate from each other from the first.

THE RATE OF SEGMENTATION.

Before I go on with the description of the later stages of development, I wish to discuss two or three points in connection with the stages which I have already described; one of these is the rate of segmentation.

As I have already stated, the time record which I have given in connection with the figures is exceptionally slow, and I will now give the intervals between certain stages in the development of other lots of eggs for comparison:

Lot A.—Warm, bright day. Eggs fertilized at 10 A. M.; segmentation commenced between 12 and 1.30 P. M., averaging about 1 P. M., or three hours after fertilization. The stage shown in Figure 26 was reached by most of the eggs between 2 P. M. and 3 P. M., or about five hours after impregnation.

The stage shown in Figure 32 was reached about 4 P. M., and seven hours after fertilization nearly all the embryos were swimming at the surface.

Lot B.—Cool day. Eggs fertilized at 10.30 A. M. About half of the eggs developed, and segmentation commenced between 12.30 and 2 P. M., or about three hours after fertilization. The stage shown in Figure 26 was reached in about twelve hours, and the stage shown in Figure 32 was reached by a very few eggs during the second day, but at the end of the second day all were dead.

Lot C.—Very cold; hail and rain. The eggs from several ripe females were fertilized, but no changes followed, and all the eggs soon decayed.

Another lot of embryos, which were about three days old, and in the stage shown in Plate III, Figure 38, also died.

Lot. D.—Day quite cold. The eggs from three females were very carefully fertilized with a mixture of the semen from three males at 10 A. M. About one in one hundred commenced segmentation between 1 and 6 P. M., and developed very slowly. The next day all were dead. As the eggs were perfectly ripe, and became covered with active spermatozoa, their failure to develop must have been due to the low temperature.

Lot E.—Quite cool in the morning; warm and sultry in the afternoon. Eggs fertilized at noon, and segmentation commenced in about two hours. At 7.30 P. M. about half of them had finished segmentation, and at 11.15 P. M. most of them were in the stage shown in Figure 32. On the fourth day most of them were doing well, and had reached the stage shown in Figure 42, when a fall in the temperature killed all of them.

Lot F.—Rather warm. Eggs fertilized at 6 P. M., and the next morning at 5, or eleven hours after fertilization, some were in the stage 32, and some in the stages 36 and 37.

Lot G.—Day quite warm. Eggs fertilized at 8 P. M. At 10.15 P. M., or a little more than two hours after fertilization, nearly all of them were in the early stages of segmentation, and at 5 A. M., or nine hours after fertilization, they were in the stage shown in Figure 37, and in forty-eight hours they were in the stage 42.

Lot H.—Very hot day. Segmentation was completed two hours after fertilization, and in two hours and a half the embryos were in the stage 32, and in forty-eight hours in the stage shown in 43.

I was so far from the water during my investigations that I was not able to make any observations upon the temperature of the oyster beds during the spawning season, but the cases

which I have selected above show the dependence of the young upon continuous warm weather.

The past spring and summer were unusually cool, and it was not until the middle of July that the weather was warm for more than three or four days in succession, and my failure to find any floating embryos in the open ocean may be due to the fact that they were killed by the cold as fast as the eggs were laid. After the middle of July I found a few embryo at the surface of the water of the Sound.

EXCEPTIONS TO THE NORMAL METHOD OF SEGMENTATION.

The method of segmentation, as I have described it, is the normal method, and is followed exactly by a very large proportion of the eggs—by more than 90 per cent. of them, I should think; but a few eggs in every lot present considerable variation, especially in the earlier stages.

Plate X, Figures 54 to 62, shows one of the most common variations. If a number of eggs be carefully watched during the early stages a few will be found to reach the stage shown in Figure 13, Plate I, more directly than the ordinary eggs, without going through the process of forming the second micromere *b*, of Plate I, and then obliterating it. Figure 54 is an egg two hours and seven minutes after fertilization, and in the stage shown in Figure 4. Two minutes later it had assumed the form shown in Figure 55, which is very similar to Figure 5, except that the three lobes of the trefoil are less sharply separated. Two minutes later it had assumed the form shown in Figure 56, and one minute later the form shown in Figure 57. As shown by these figures, the second micromere does not become distinct, as in Figure 6, but the faint indication of it shown in Figure 55 quickly disappears, and the subsequent changes result in the separation of the egg into two masses, instead of three. Figure 58 is forty-five seconds later than Figure 57, and Figure 59 four minutes and fifteen seconds later. A single furrow now extends nearly across the egg, from the polar globule, and divides it into two nearly separated portions—a small one and a large one. In

one minute and a half the two were entirely separated (Figure 60), and in two minutes and fifteen seconds more (Figure 61) each part was prominent and rounded, and in five minutes more (Figure 62) they had again approached each other, and assumed the form of Figure 13. This is the variation which is most frequently met with, and it is plainly a simplification of the normal method, by which the result of the first period of activity is reached more directly. In another variation, which is met with much less frequently, the second period of rest is entirely left out, and the stage shown in Figure 18 is reached directly, as shown in Figures 63 to 66. In this case the egg passes through the stages 1, 2, 3 and 4, of Plate I, but when it assumes the trefoil form of Figure 5, a second plane of cleavage, passing through the axis of the polar globule, divides each micromere into two, as shown in Figure 63, in side view, and in 64, viewed from the formation pole.

Three of these spherules remain distinct, but in a few minutes one of them, which appears to correspond to the second micromere of the normal method of segmentation, becomes fused with the macromere, as shown in Figure 65, which corresponds to Figure 16 of the normally segmenting egg. A few minutes later it assumes the form shown in Figure 66, which is clearly the same as Figure 18. Besides these two variations, which occur quite frequently, and are sufficiently regular to demand especial notice, there are occasional irregularities, such as are always found, when a number of eggs are carefully compared, but these do not call for minute description.

THE SIGNIFICANCE OF THE SEGMENTATION OF THE OYSTER EGGS.

Our information regarding the early stages in the development of Lamellibranchs is very scanty indeed, but so far as it goes it indicates that the process of segmentation, as I have described it, is, with slight modifications, common to the whole class.

Lovén's memoir (Bidrag till Kännedommen om Utvecklingen af Mollusca Acephala Lamellibranchiata. Af S. Lovén.

kongl. Vetenskaps-Akademiens Handlinger. Stockh. 1848), contains nearly all the present knowledge of the process of segmentation in the marine Lamellibranchs. I have not the paper before me as I write, and my notes upon it, which were made several years ago, do not contain any figures, so I am not able to make a minute comparison, but the figures which he gives of the segmenting eggs of Crenella and Cardium are essentially like the same stages in the development of the oyster egg, and show that in these two genera the egg divides into a single macromere situated at the nutritive pole, and a number of smaller micromeres situated at the formative pole, and that the macromere is gradually surrounded by a layer of ectoderm cells, which are formed in part by the division of the micromere and in part by the separation of new micromeres from the macromere.

According to the short abstract which Brobetsky (Studien über die Embryonale Entwickelung der Gasteropoden, von Dr. N. Brobetsky aus Kiew. Arch. f. Mik. Anat. 1870, pp. 95—Taf. viii–xiii) gives of Lovén's observations upon the segmentation of the egg of Crenella, p. 104, the resemblance to the oyster does not stop here, but extends to more minute details. The egg divides, as it does in the oyster, into a first and a second micromere, and a macromere which is more transparent than the micromeres. After these three spherules have become distinct, one of the micromeres fuses with the macromere, and all traces of it disappear for a time. The other then flattens down upon the compound mass, and the egg assumes the condition shown in Figure 13. Soon both the first and the second micromeres again become prominent, and then divide, so that there are now four micromeres at one pole of the egg and one larger macromere at the other. One of the four now fuses with the macromere again precisely as it does in the oyster, and a stage like my Figure 19 is reached. As in the oyster, Lovén notices the alternation of periods of rest and activity for some time longer, and the agreement with the oyster appears to be most complete.

Our knowledge of the early stages in the development of the

fresh water Lamellibranchs also shows a great similarity between them and the oyster.

Flemming has given a very minute account of the segmentation of the egg of Anodonta (Studien in der Entwickelungsgeschichte der Najaden, von Walther Flemming in Prag. mit 4 Tafeln. Aus den lxxi. Bande der Sitzb. der k. Akad. der Wissensch. III Abth. Febr. Heft. 1875. Sitzung am 4. Februar, 1875), and his account of the process (pp. 38–58, and his figures, Taf. II. Figures 1–20), show that the segmentation is much like that of the oyster, except that the segmentation cavity makes its appearance very early.

The segmentation of the egg of the Anodonta differs from that of the oyster egg in a number of minute details, but not so much so as to obscure the fundamental similarity. Flemming's Figure 6, of Plate II, obviously represents the same stage as my Figure 13; his Figure 11 is the same as my Figure 19; his Figure 13 the same as my Figure 22; his Figure 17 the same as my Figure 26; his Figure 18 the same as my Figure 28, and his Figure 23 the same as my Figure 32. The polar globules are shown in most of his figures, and prove that, as in the oyster, the growing edge of the layer of ectoderm is at the point which is farthest from these bodies.

The early stages in the development of Unio have been figured and described at length by Rabl. (Ueber die Entwickelungsgeschichte die Malermuschel. Eine Anwendung der Keimblätter—Theorie auf die Lamellibranchiaten, von Carl Rabl, Jenaische Zeitschr, X, 1876, 310–395; Taf. X–XII), and his account shows a still closer agreement with the oyster than is presented by Anodonta.

The segmentation cavity of Unio makes its appearance very early, but in other respects there are few differences between his account and my own, except that I have not found in the oyster the two large cells which he says become pushed into the segmentation cavity of Unio, and give rise to the mesoderm. In a paper which is now in press, on the formation of the digestive tract in the fresh-water Pulmonates, I have been compelled to call attention to the fact that certain figures in an earlier paper by Rabl, on the development of

Pulmonates, are imaginary and unlike anything in nature, and I therefore take pleasure in stating here that my own work upon the oyster tends to show the perfect accuracy of the observations in the present paper, not only so far as the early stages are concerned, but also as regards the later history of the embryo.

Figure 7, Plate X, of the egg of Unio is clearly the same as my Figure 13; Figure 10 is almost identical with 19 of the oyster; Figure 11–14 are very similar to 20–23 of the oyster; Figure 15 differs from 26 of the oyster only in the presence of a segmentation cavity; 17 and 18 are the same as 27 and 28 of the oyster, except that they are not flattened vertically, and his figures 28 and 30 are essentially the same as my 32 and 38.

I have already shown that the stage 13 of the oyster egg, which is usually reached by passage through a number of intermediate stages, and by the formation and obliteration of a third spherule, may be reached by a more direct process, which is exceptional in the case of the oyster. It is interesting to notice that Flemming and Rabl agree that the indirect form of segmentation which is normal in the oyster, is wanting in Anodonta and Unio, and that this stage is reached directly in a manner which is only occasionally met with in the oyster.

There can be no doubt, that in Anodonta at least, the trefoil stage is really wanting, and has not simply been overlooked, for Flemming actually watched and has figured the change of the spherical unsegmented egg into the form shown in his Figure 6.

In addition to the observations above referred to, we have a number of papers which deal with the development of various species of Cycladidæ, and contain some observations upon the early stages, but no one has succeeded in getting anything like a complete series of observations, and those which are recorded are not at all in harmony with each other. In his "Contributions to the Developmental History of the Mollusca, No. I, The Early Development of Pisidium pusillum," (Phil. Trans. 1875, vol. 165, part I), Lankester gives a

short description, pp. 2 and 3, and a few figures, Plate I, Figures 4, 5, 6, 7, 8, 16 and 17, of the process of segmentation. His observations are very fragmentary and unsatisfactory, but they would seem to indicate that the segmentation is total and regular, and not at all like that of the oyster.

Ganin reaches a similar conclusion, and says (Beitrag zur Lehre von den embryonalen Blätter bei den Mollusken. Abst. in Hoffman u. Schwalbe's Jahresberichte. 1. 1872), that in Cyclas the segmentation is total and regular, and results in the formation of a spherical layer of similar cells around a central cavity.

Von Jhering and Rabl, on the other hand, give observations which indicate that the segmentation is, on the whole, like that of the oyster.

Von Jhering says (Ueber die Ontogenie von Cyclas und die Homologie der Keimblätter bei den Mollusken, Zeit. f. Wiss. Zool. 1876- xxvii), that although he did not succeed in getting as complete a series of forms as Flemming has figured in Anodonta, the stages which he has found show that the process of segmentation takes place about as it does in Anodonta, and Rabl says, p. 340, that he has observed two stages in the segmentation of Cyclas, and that the mode of segmentation is the same here as in Unio. In Taf. XII, Fig. 58, he shows one of these stages, which differs from one of the later stages of the segmentation of the oyster egg only in the presence of a large segmentation cavity.

These references, which cover the whole field of our exact knowledge of lamellibranch segmentation, show that probably in the Cycladidæ, and certainly in Unio, Anodonta, Crenella and Cardium, we have nearly the same mode of segmentation as in the oyster; but that the normal method of oyster segmentation is indirect, and may be simplified occasionally in the oyster, and normally in Unio and Anodonta, by the omission of many of the stages of the process and the retention of those only which lie in the direct line of development. I have described this process in the oyster with great minuteness, and perhaps with tedious exactness, since I believe that it

is of phylogenetic significance, and indicates the origin of the Class Lamellibranchs.

The distinctive characteristics of this form of segmentation are the very small size of the eggs; the appearance of bilateral symmetry with the first cleavage, and the indication at the same time of the anterior and posterior ends and right and left sides and dorsal and ventral surfaces of the adult; the separation of the egg at the beginning of segmentation into a germinative portion, and a portion which is morphologically comparable, during the process of segmentation, to a food yolk, although it is less granular, both in the oyster and in Crenella, than the germinative portion, and at a later stage undergoes segmentation, and forms the wall of the digestive cavity, so that it has none of the physiological characteristics of a food-yolk; and the fact that many of the stages in the process of segmentation have no functional importance and may be suppressed. Outside the Lamellibranchs, whenever we have very small simple eggs among the Mollusca, the embryo is radially symmetrical around a central axis, which passes through the polar globules, and it presents, during the process of segmentation, few points of resemblance to the egg of the oyster at the same period. In support of this statement, I may refer to Lankester's figures of the eggs of Nudibranchs and Opisthobranchs (Developmental History of the Mollusca, Plates 5 and 9), to Fol's figures of the eggs of Pteropods and Heteropods (Etudes sur dévelopment des Mollusques. Arch. d. Zool. exp. et gen. 1875), to my own observations on the segmentation of the Pulmonate egg (Studies from the Biological Laboratory of the Johns Hopkins University, 1879), and to Bütschli's and Lankester's accounts of the segmentation of the egg of Paludina, ("Entwickelungsgeschichte von Paludina vivipara." Zeit. f. Wiss. Zool. 1877, and "On the Coincidence of the Blastopore and Anus in Paludina vivipara." Quart. Mic. Journ. 1876.)

Rabl has briefly discussed the relation of the bilaterally symmetrical, irregular segmentation of the lamellibranchiate egg, to the regular axially symmetrical segmentation of the egg in most Gasteropods (Entwickelungsgeschichte der Mal-

ermuschel, pp. 338–345), and concludes that the first is an adaptational modification of the last, which gives the Lamellibranch an advantage in the struggle for existence, and which has therefore been preserved by natural selection. He says, p. 244: "Die inequale Furchung dem sich entwickelnden Embryo einen Vortheil gewährt, und dass dieser Vortheil um so grösser ist, je frühzeitiger sich eine Ungleichheit in den Furchungsproducten bemerkbar macht."

I think, however, that all the evidence which I have given points towards the conclusion that the peculiar segmentation of the Lamellibranchs is due rather to the retention of characteristics which were adapted to some past condition of things than to direct adaptation to the present conditions of life; and we must therefore look for its origin somewhere else than in the regular radially symmetrical segmentation of the small simple eggs of the Pulmonates. I think that a comparison of my account and figures with the figures and description given by Brobetsky and myself of the segmentation of the egg in those Prosobranchs where the eggs are few in number, large, and contain a large food-yolk which is of physiological importance, will fully support the conclusion that we have here the ancestral form of segmentation, which is retained by the small eggs of the Lamellibranchs.

In a paper entitled "Preliminary Observations on the Development of the Marine Prosobranchiate Gasteropods," (Chesapeake Zoological Laboratory, Scientific Results of the Session of 1878, p. 121), I have given outline figures of a few of the stages in the segmentation of the egg of Urosalpinx, Plate 8, Figures 1, 2, 3, 4, 9 and 10, and a reference to these figures will show that there is considerable resemblance between this and the oyster egg. A few small transparent micromeres separate off from the surface of the large food yolk, which occupies the nutritive pole of the egg, and gives rise to a blastoderm which spreads over the surface of the food-yolk; growing at one edge, partly by the division of the micromeres and partly by separation of new ones from the yolk.

From the beginning of segmentation the egg is bilaterally symmetrical, and the general resemblance to the oyster egg is

easily seen, although it is not at all complete or minute, but according to Brobetsky (Studien über die embryonale Entwickelung der Gasteropoden, von Dr. N. Brobetsky in Kiew. Arch. f. Mic. Anat. xiii. 1877, pp. 95–170. Taf. viii–xiii), the early stages in the development of Nassa are almost exactly the same as those of the oyster. The egg of Nassa has a large functional food-yolk, and the blastoderm which surrounds it is not simply an ectoderm, since it gives rise to all the germ layers; but before the differentation of the spherules at the formative pole has made its appearance, segmentation takes place exactly as it does in the oyster, and the first ten figures of Brobetsky's first plate might have been used, without the least change, to represent the stages of the oyster egg which I have given in my first nineteen figures. I hope to publish soon a short paper, illustrated by a comparative table of outline drawings of the segmenting eggs of various Molluscs, in order to illustrate my conception of their significance, but at present I must refer to the various original papers. A reference to Brobetsky's account and figures will show that his Figure 1, Taf. VIII, is almost exactly like my Figure 4; his Figure 2 like my Figure 5; his Figure 3 like my Figure 7; that his Figure 4 shows the change illustrated more at length in my Figures 8, 9, 10 and 11; that his Figure 5, A and B, shows the same stage as my Figure 13; that his Figure 6 is the stage 15 of the oyster; his Figure 7 the stage 16; and that his Figures 8, A and B, are the same as my Figures 18 and 19. The sections of these stages which Brobetsky gives in Plate IX, indicate that the early appearance of bilateral symmetry in Nassa and Urosalpinx is a condition of things which has been brought about by the presence of a large food-yolk, which does not undergo segmentation, and this conclusion is confirmed by a comparison with Brobetsky's account of the development of Natica and Fusus, where a true food-yolk is lacking, and the embryo is radially symmetrical during the early stages.

The facts which I have given in regard to the oyster show that the peculiar early stages of segmentation are of no func-

tional importance, since they may be omitted occasionally in the oyster, and normally in Unio and Anodonta. In Nassa we find them again, but they are here associated with the presence of a food-yolk, and I think we are, therefore, justified in concluding that the one-sided, bilaterally symmetrical segmentation which there is occasion to regard as characteristic of the Lamellibranchs, indicates that the Lamellibranchs are the descendants of an ancestral form, in which the eggs were few, large and provided with a food-yolk; that this has been lost, as the eggs became small and numerous, but that the peculiar form of segmentation which was then necessary has been retained perfectly by the oyster, and incompletely by other Lamellibranchs.

In a paper which was printed several years ago, (The Affinity of the Mollusca and Molluscoida, Proc, Boston Soc. Nat. Hist. XVIII, Feb. 2, 1876, pp. 225–235), I called attention to a number of reasons for holding the opinion that the Lamellibranchs must be regarded as a side branch from the main stem, of which the Gasteropods are a much more direct continuation, and that all attempts to trace the phylogeny of the higher Mollusca through the Lamellibranchs to lower invertebrates are erroneous and useless; that the highly specialized "veliger" of the marine Prosobranchs is to be regarded as the proto-mollusc, and that the Gasteropods are descended from this with less modification than the Lamellibranchs. The growth of our knowledge of the invertebrates has furnished us with much more material for comparative study than was available at the time this paper was written, and seems to indicate very clearly that the ciliated embryos of the Echinoderms, Gephyreans, Annelids, Polyzoa, Brachiopods, Rotifera, Molluscs and other invertebrates are, all of them, modifications of a common ancestral type, and that the origin of these great groups is indicated by their embryology.

At the same time the careful comparison of adult animals has directed attention to the fact that, in many cases, those groups in which the structure of a type is reduced to its simplest expression, are not ancestral, but degraded, forms. In

such forms as the Lernæans and Entoconcha the degradation is due to actual parasitism, but degradation may be effected by any circumstances which diminish the complexity of the environment and thus render a simplification of structure advantageous; and the view that the characteristics which are most distinctive of the Lamellibranchs have been produced as adaptations to their sedentary life, and that their remote ancestors were similar to those of the higher molluscs, is supported by ample analogy.

It is clear that as an animal becomes adapted to a sedentary life its diffusion must be provided for by an increase in the number of eggs or embryos, and we can easily see that, if the ancestors of the Lamellibranchs were animals which laid only a few large eggs, the gradual acquisition of a sedentary habit would demand a decrease in the size of the eggs, in order to permit an increase in their number.

The evidence which the oyster egg furnishes to show that it was at one time provided with a food-yolk, which has been lost, therefore confirms the view that the Lamellibranchs are a degraded or simplified group.

I take the opportunity, while correcting the proofs of this paper, to call attention to a highly interesting discussion of a kindred subject, which is contained in an elaborate paper, by Rabl, on the development of Planorbis, in the last number of the Morphologisches Jahrbuch, which reached me after this paper was written.

Rabl gives a comparative table of figures, in part original and in part selected, of the early stages in the segmentation of the eggs of a number of Gasteropods, Heteropods and Pteropods, and shows that there is a complete series of forms between the radially symmetrical segmentation of the Planorbis egg, and the egg of Nassa.

His series of figures fully proves his conclusion that the peculiar segmentation of Nassa has been brought about by the gradual localization of a specialized food-yolk, and I think all embryologists will agree with him in holding that his facts show the fundamental similarity in plan of segmentation among the Gasteropods and Pteropods.

Von Jehring's attempt to show that the early stages in the development of Gasteropods differ fundamentally according as they belong to one or the other of the two *phyla* between which he proposes to distribute them, is thus shown to be ab solutely without a basis of fact.

In a foot-note to his paper Rabl says that this similarity of ground-plan does not extend to the Lamellibranchs, but the embryology of the oyster shows that it does.

In the Lamellibranch with which he is most familiar, Unio, the process of segmentation is greatly abridged, and its true significance is only seen when it is compared with that of the oyster. This comparison shows that the eggs of Lamellibranchs have passed through a change which is exactly the reverse of the one which Rabl has traced, and the peculiar interest of his paper lies in the fact that while he was tracing the process by which the food-yolk was acquired, I was engaged in tracing the process by which it has been lost, and that the form with which his series ends is the one with which my series begins.

It hardly seems necessary for me to say that I do not wish to be understood to hold that the Lamellibranchs are the descendants of Nassa, but simply that their ancestors laid eggs like the eggs of Nassa.

THE FORMATION OF THE DIGESTIVE TRACT.

At the stage shown in Figures 32 and 33, the primitive digestive tract opens by a wide blastopore, which is situated upon what is to become the dorsal surface; and the outline of the body in front of it is rounded and carries the velum, while behind it the outline is angular and pointed. At the stage shown in Figure 36, the outline of the body is nearly the same, and the external changes are so slight that the side which is below in this figure is at once seen to be the same as that which is below in Figure 32. This surface is still marked by a transverse groove, but the blastopore has closed up completely, and one valve of the shell has made its appearance at each end of the groove. Posterior to the groove the papilla,

a, runs backwards and downwards, and in front of it the outline of the body is rounded and bears the velum. The time when the valves of the shell make their appearance varies slightly, but I have seen them when the transverse groove was as well marked as it is in Figure 35, and this fact, as well as the similarity in the outline of Figures 32 and 36, does not seem to leave room to doubt that the shell occupies the position of the blastopore. At the stage shown in Figure 36, the endoderm is a pretty compact mass, separated, around its entire circumference from the body wall, and with no traces of a central cavity, although it is perfectly possible that a small cavity may be present.

Figure 37 is an embryo a few hours older, viewed from the right side, with its dorsal surface uppermost. The shell *s* is much larger than it was at the preceding stage, and is usually quite irregular in outline, although a few embryos were found at this as well as at the stage 36, in which each valve was perfectly regular in outline, pear-shaped, and placed with the narrow end nearest the middle line. A little posterior to the shell is the anal papilla *a*, which now carries a few short, stiff cilia or setae. The relative positions of the shell, anal papilla and velum in the preceding stages seem to show with satisfactory clearness that the side which is uppermost in this figure is that which is below in most of the preceding figures, and which I have called dorsal.

The digestive tract is now much larger than at the preceding stage, and its centre is occupied by a distinct cavity, the wall of which is ciliated. At a point nearly opposite the shell this cavity opens externally by a new opening, *m*, and small particles of food now find their way into the central cavity, where they are kept in rotation by the cilia. At this stage the margins of the opening *m* can be protruded so as to form a projecting sucking disk, by which the embryos adhere to each other and to foreign bodies.

The series of stages which I have figured seems to show that this new opening is almost directly opposite the position which the blastopore occupied at stage 32.

In from two to four days after fertilization, the embryo assumes the form shown in Figure 38, which is a view of the right side. The shell is now large and regular in outline, and covers nearly half of the surface of the body. The digestive tract now has two external openings, *m* and *an*, which are close together on the ventral surface of the body. In a side view, Figures 38 and 39, it was almost impossible to say whether either or both of these communicate with the digestive cavity, but embryos were frequently found with the two valves of the shell stretched out into the same plane, and with the body pulled up and flattened against the shell, and in a dorsal or ventral view of such an embryo, it was easy to see that both openings do communicate with the central cavity. Figure 41 is a dorsal view of an embryo at the same stage as Figure 38, but with its valves extended.

The stomach is seen through the shell, and when the animal is in this position, is pear-shaped, with the broad end of the pear in front and the narrow portion on the median line behind, and the anus, *a*, could be seen at the tip of the stalk, while the mouth, *mo*, is in the centre of the broad anterior end.

It will be seen that these openings are much farther apart when the body is stretched by the opening of the valves than when these are more inclined to each other, as they are in the side view, Figure 38. The anterior opening, or mouth, 38, 39 and 42, *mo*, is not, at this stage, a simple tube, but a large, nearly spherical pouch, which is capable of protrusion from the surface of the body. I was not able to determine whether these two openings were or were not formed by the division of the single opening shown at the stage 37, and therefore cannot say whether the opening in this figure is the mouth, the anus, or both.

In an embryo four or five days old, Figures 42 and 44, the digestive tract has increased considerably in size, and the posterior portion is much smaller than the anterior part, and forms a tubular intestine, *i*. At the stage shown in Figure 44 the lateral walls of the stomach begin to fold out, so as to

form a pair of pouches or diverticula, the halves of the liver, *l*, in the walls of which numerous highly refractive oil-globules make their appearance.

Our knowledge of the digestive tract in the Mollusca is at present in the greatest confusion; and in most molluscs the difficulties of observation are so great at the time when the most important changes take place, that it is almost impossible to obtain any perfectly satisfactory results.

The oyster presents exceptionally favorable conditions for investigating this question, and the observations above described seem to show conclusively—

1st. That there is an invaginate gastrula stage.

2d. That the blastopore closes completely, leaving the digestive tract without an opening.

3d. That the shell appears at the point which the blastopore previously occupied.

4th. That first one and then two openings from the outer surface into the digestive tract make their appearance almost directly opposite the position of the blastopore, and that one of them becomes the mouth and one the anus.

The most thorough and satisfactory account of the origin of the digestive tract in Lamellibranchs is that of Rabl (Entwickelung der Malermuschel), and the process, as he describes it, is like what I have observed in the oyster, so far as all the leading points are concerned. At the close of segmentation the single large macromere of Unio divides into a number of large cells, which cover the dorsal surface of the embryo, Taf. X, Fig. 23. They then push into the body cavity, so as to form a primitive digestive cavity, which opens by a dorsal blastopore. Taf, XI, Fig. 28.

The shell now appears, and covers up the dorsal surface, Taf. XI, Fig. 34, and the blastopore closes up, thus leaving the digestive tract without any opening. Taf. XII, Fig. 54.

A new opening is now formed by the invagination of the integument, at a point on the ventral surface, Figure 54, which is at some distance from the blastopore, but not directly opposite it, as in the oyster.

Flemming was not able to obtain much information regarding the history of the digestive tract, but as he has conscienciously adhered, in his description, (Entwickelungsgeschichte der Najaden), to what he has been able to actually see, his account agrees with Rabl's so far as it goes, and there is every reason to believe that the process is the same in Unio and Anodonta and the oyster. Flemming shows that in Anodonta the single large macromere divides up into a layer of large cells which occupy the dorsal surface of the body, and subsequently become covered by the shell, but he was not able to trace their future history.

The various accounts of the origin of the digestive tract in the Cycladidae are so very contradictory and irreconcilable that it does not seem worth while to try to get at the truth by comparing them, without making any original observations, and Rabl's paper and my own fairly represent the present state of our knowledge of the origin of the digestive tract in Lamellibranchs. The difficulties of observation are so great that the observations of an investigator who did not direct especial attention to the subject are not likely to afford information of much value, and at the time Lovén's paper was written the problems of invertebrate embryology were so different from those of the present day that no conclusions regarding the history of the digestive tract can be drawn from his figures.

THE DEVELOPMENT OF THE OYSTER AND THE GASTRULA THEORY.

Salensky has given (Bemerkungen über Hæckel's Gastraea—Theorie. Arch. f. Naturgeschichte, 1874), a very brief account of the origin of the digestive tract in the oyster, illustrated by three figures. He says, p. 150, "das erste Stadium der Entwickelung ein Embryo ist, welcher aus zwei Schichten besteht, und in Inneren keine Höhle trägt," Figure 1, Taf. V, "dass sich dann verschiedene äussere Organe und eine Mundeinstülpung bilden, und schliesslich im Inneren des Entoderms eine Darmhöhle entsteht," Figures 2 and 3.

After a very exhaustive and able review of the facts in embryology with which we were at that time acquainted, he con-

cludes that the embryology of the oyster and that of other Metazoa proves that the starting point in their development is not the gastrula stage, but a "planula" stage, in which the embryo consists of two layers of cells without a central cavity; that this planula stage may be so modified as to give rise to a "blastula" stage, in which a double layer of cells surrounds a central cavity without an external opening; that while the blastula is to be regarded as a modification of the planula, the planula stage may be omitted, and the embryo may at once assume the blastula form; that the formation of the stomach-cavity is a later and secondary occurrence in the history of development, that it takes place at different stages in different animals, and has no place in a conception of the general plan of development; that either the planula or the blastula may complete its development by passing through a "gastrula" stage, which, however, is not the primitive condition of the embryo, but a secondary modification of later formation, which may or may not present itself; that the "gastrula" stage of development is not the common starting point for all Metazoa; and that the hypothetical "Gastraea" cannot be regarded as the ancestral form from which the higher groups have been derived, pp. 159–173.

A comparison of his figures of the oyster embryo with my own shows that his Figure 1 represents a stage between my Figures 36 and 37; his Figure 2 one at the same stage as my Figure 38, and his Figure 3 one at the stage as my Figure 45.

He is correct in the statement that the embryo shown in his first figure consists of a central mass of endoderm which is entirely surrounded by the ectoderm, and in which no cavity can be seen; and that the mouth and anus are formed and the stomach-cavity becomes visible at a late stage, after the shell and velum have appeared.

My own observations, and those of Rabl on Unio, show, however, that the so-called "planula" of the oyster is preceded by a true invaginate gastrula stage, and that, so far as the development hypothesis above quoted rests upon the embryology of the oyster, it is directly opposed to the facts.

Salensky's hypothesis seems to be almost identical with Ray Lankester's so-called "planula theory," published the year before (On the Primitive Cell-layers of the Embryo as a Basis of Genealogical Classification of Animals. Ann. and Mag. Nat. Hist., May, 1873: and, Notes on Embryology and Classification, for the use of Students. London: 1877), the essential difference between which and Haeckel's gastrula theory is the conception of the gastrula as a secondary modification of the planula. The fact that in Unio and in the oyster a planula is formed by the modification of a gastrula, would seem, so far as it goes, to be as adverse to Lankester's hypothesis as it is to Salensky's. Von Jhering's view, that the primitive embryonic form among the Mollusca is not a gastrula, but a "leposphaera," does not seem to involve any new conception, for according to his definition (Ueber die Ontogenie von Cyclas, und die Homologie die keimblätter bei den Mollusken, von Dr. Hermann von Jhering. Zeitschr. f. Wiss. Zool. xxiv. Marz. 1876, pp. 414–438), his leposphaera is the same as Lankester's and Salensky's planula. "Die Leposphaera wird also aus zwei concentrischen Zellschichten gebildet von denen die äussere oder das primäre Ectoderm die innere oder das primäre Endoderm umgiebt, wie die Schalle einer Nuss den Kern einschliesst. Der bleibende Mund entsteht im Ectoderm der Leposphaera, der Oesophagus entweder vom Munde aus, wie bei den Gasteropoden, oder vom primäre Endoderm aus, wie bei den Lamellibranchien," p. 429.

The facts in the development of the oyster are thus seen to be opposed to the only consistent and probable hypothesis which has ever been proposed in the place of the gastrula theory; the hypothesis that the planula is the primitive embryonic form, of which the gastrula is a specialized modification; but it must not be concluded that since the embryology of the Mollusca is opposed to the alternative hypothesis it therefore tends to support the hypothesis that the gastrula stage has a phylogenetic significance, and shows the descent of the Mollusca from an ancestral gastraea.

The most satisfactory and trustworthy papers which we possess upon the development of the Mollusca show that

while there is in many cases a true gastrula stage, its orifice bears no constant relation to the definitive mouth and anus.

There does not seem to be any valid reason for disputing Fol's statement (Etudes sur le développement des Mollusques, I. Ptéropodes, arch. d. Zool. exp. et gen. IV, 1875), that on the Ptéropods the orifice of invagination persists and becomes the definitive mouth. We have the testimony of both Lankester and Bütschli ("On the Invaginate Planula or Diploblastic phase of Paludina vivipara," by E. Ray Lankester. Quart. Jour. Mic. Sc. XV, 1875; and "On the Coincidence of the Blastopore and Anus in Paludina vivipara," by E. Ray Lankester. Quart. Journ. Mic. Sc. XVI, 1876, and "Entwickelungsgeschichtliche Beiträge. I. Jur Entwickelungsgeschichte von Paludina vivipara, von O. Bütschli, zeitsche. f. Wiss. Zool, XXIX), to prove that in Paludina the orifice of invagination persists and becomes the anus.

In the oyster the orifice of invagination closes up, and forms the shell and in the Squid it is perfectly certain that the point where the blastoderm folds in over the food-yolk has no connection with either the mouth, the anus or the shell-gland.

It is not necessary to extend the above list by references to observers who have given still different accounts. There are fine grounds for disputing the correctness of many of these papers, but I do not think the present state of our knowledge gives us any reason for doubting the conclusions of Fol, Lankester and Bütschli; my own observations on the oyster are confirmed by Rabl, and in a future paper I hope to show that the Squid is such a favorable subject for study that there is no chance for error in the statement which I have given above, and we may conclude that the present condition of embryology fully justifies Lankester's statement that in the Mollusca there is no necessary connection between the blastopore and either the mouth or the anus.

Now there cannot be the least doubt that the molluscan mouth is the same opening in all the classes, and that the anus is also homologous throughout the whole group.

It is perfectly possible that the mouth and anus might exchange functions during the evolution of a group of animals, or that one or both might be replaced by new openings, and Semper (Stammverwandschaft der wirbelthiere und wirbellosen), und Dohrn (Ursprung wiebelthiere), have given very convincing evidence that such a change has actually taken place in the vertebrate mouth during the evolution of these animals, but there is not the least reason for believing that anything of the kind has taken place during the evolution of the classes of Molluscs, but the whole of the evidence furnished by Comparative Anatomy and Embryology tends to show that nothing of the kind has taken place, but that the mouth and anus, and the shell-gland as well, can be homologized perfectly in all the classes of true Molluscs, and that they are not only homologous with each other, but must be perfectly homologous also with similar structures in the ancestral form of which the classes of Molluscs are modifications.

If there has been a time when all the classes of Molluscs were represented by a single form, a *proto mollusc*, with a mouth, an anus and a shell-gland, which were homologous with the similar structures in all its descendants, this ancestral form must have been much later than the "gastræa," and if it was produced by evolution from a gastræa at all, it is plain that the mouths, anuses and shell-glands of all the classes of Molluscs must bear the same relation to the organs and openings of this ancestor—the "gastræa."

The fact that the blastopore of the gastrula stage does not, according to our best information, bear any such constant relation to the body of the adult, therefore opposes the conclusion that this stage has a phylogenative significance, and we are fully warranted in the statement that the present state of our knowledge forbids the acceptance of the gastrula theory as an established generalization of scientific value.

I do not think, however, that we are justified in going farther, and concluding the theory is disproved by the facts of molluscan development.

The early stages of the development of the different classes of vertebrates presents, at first sight, few points in common,

yet Balfour has shown (A Monograph on the Development of the Elasmobranch Fishes, by E. M. Balfour, M. A. London: 1878), that the types of the early development of all vertebrate animals can be easily derived from that of the typical gastrula.

The general occurrence of a gastrula stage in so many widely separated animals is certainly the most pronounced feature in embryology, and it is possible that a more complete acquaintance with the development and phylogeny of the Mollusca may show that the facts held do not, in reality, oppose the view that it is an ancestral form, and the conclusion which the facts seem to justify is not that the gastrula theory is proved or disapproved, but that our acquaintance with the facts must be very much greater than it is at present before we shall be prepared to establish any general hypothesis as to the ancestry of the Metazoa.

THE SHELL.

The two valves of the shell of the oyster originate separately, as I have already stated, while in some other Lamellibranchs the separation of the valves is brought about at a later stage of development, by the division of a continuous embryonic shell.

In Cyclas the embryonic shell makes its appearance as a simple, nearly circular cup, which occupies the dorsal midline of the body, and soon becomes saddle-shaped, and prolonged to form two flaps, which run down into the sides of the body. This embryonic shell does not contain any calcareous matter, but appears to be wholly made up of a chitinous excretion from the cells of the shell area. After it has extended out onto the sides of the body, calcareous matter begins to be deposited on its inner surface, at two points, one on each side of the body. These centres of calcification grow on all sides, and become the calcareous valves of the shell, and the flaps of the primitive shell become the epidermic coverings of the outer surfaces of the two valves. The two centres of calcification grow towards, but not quite up to the medium

line of the dorsal surface, and these upper edges are united by the middle portion of the primitive shell, which becomes converted into the hinge ligament.

In Anodonta, and apparently in Unio, the process is somewhat similar, but each calcareous valve is formed by the union of a number of patches which are deposited on the inner surface of the embryonic shell at several centres of calcification.

In the oyster the primitive shell appears to be wanting, and the two valves of the shell correspond to the two centres of calcification which are present in Cyclas.

The fact that the primitive shell of Cyclas or of Anodonta closely resembles the embryonic shell of a Gasteropod, a Pteropod or a Cephalopod in appearance and shape, as well as in position and method of formation, would seem to indicate that the manner in which the shell of Cyclas is formed is the primitive method, and the process, in the oyster, a secondary modification.

THE MANTLE.

The manner in which the lobes and cavity of the mantle are formed in the oyster appears to differ slightly from the process as it is exhibited during the development of the fresh-water Lamellibranchs.

In Anodonta the mantle cavity is formed by an invagination of the body wall between the free ventral edges of the valves, and in Cyclas the mantle folds off from the sides of the body in advance of the growing shell. The process in the oyster is about half-way between that in Cyclas and that in Anodonta. The mantle is formed as a ridge or fold of the integument on each side of the body, but this ridge is situated at the ventral edge of the shell, not, as in Cyclas, in advance of it.

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THE DEVELOPMENT OF THE OYSTER.

BY W. K. BROOKS.

EXPLANATION OF THE PLATES.

Unless the contrary is stated the figures are drawn with a magnifying power of 250 diameters; Zeiss. F. 2, but it was necessary to amplify the sketches considerably in order to reproduce, by the process of photo-engraving, the features which this magnifying power rendered visible, and the figures as they are reproduced are of about twice the diameter of camera sketches made with the same magnifying power.

The first thirty-two figures show the process of segmentation. Figure 1 is an egg at the end of the first period of rest; Figures 2, 3, 4, 5, 6 and 7, the changes during the first period of activity; Figures 8, 9, 10, 11, 12 and 13, the changes during the second period of rest; Figures 14, 15 and 16, those which take place during the second period of activity; 17, 18 and 19, those which take place during the third period of rest; 20 and 21, during the third period of activity; 22, during the fourth period of activity; 23, during the fifth period of activity, and the remaining figures show more widely separated stages. In all the figures of segmentation, except 29, 30 and 31, the formative pole is above and the nutritive pole below.

PLATE I.

Figure 1.—Eggs two hours and seven minutes after fertilization. It is now perfectly spherical, with an external membrane, and the germinative vesicle is not visible.

Figure 2.—The same egg two minutes later. It is now elongated; one end is wider than the other, and a transparent area at the broad end marks the point where the polar globules are about to appear. At the opposite end the external membrane is wrinkled by waves which run from the nutritive towards the formative pole in rapid succession for about fifteen seconds.

Figure 3.—The same egg two minutes later.

Figure 4.—The same egg two minutes later. The yolk has become pear-shaped. The polar globule has appeared at the formative pole, in the middle of the broad end of the pear, and the nutritive end of the egg is now less granular than the formative end.

Figure 5.—The same egg two minutes later. Three equidistant furrows have made their appearance, separating it into a single mass at the nutritive pole, and two at the formative pole. At this stage the three masses are about equal in size.

Figure 6.—The same egg two minutes later. The first micromere, *c*, is now perfectly separated, and smaller than the second, *b*, and each is smaller than the macromere, *a*.

Figure 7.—The same egg one minute later. Both micromeres are separated and are spherical, as is also the macromere. This stage ends the first period of activity.

Figure 8.—The same egg forty-five seconds later. The two micromeres have begun to fuse with each other, and the second micromere, *b*, is also partially fused with the macromere, *a*.

Figure 9.—The same egg one minute later. The first micromere, *c*, has also begun to unite with the macromere.

DEVELOPMENT OF THE OYSTER. Plate I.

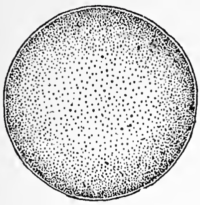


Fig 1

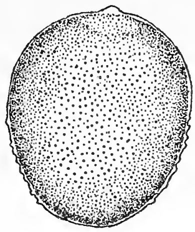


Fig 2.

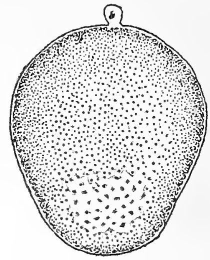
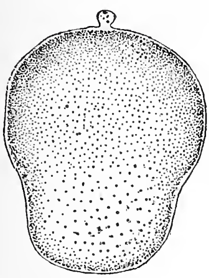


Fig 3.



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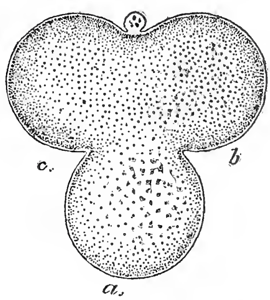
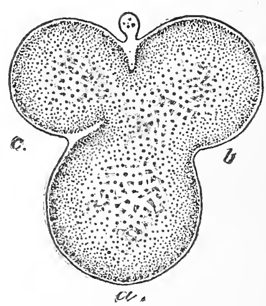


Fig 5.



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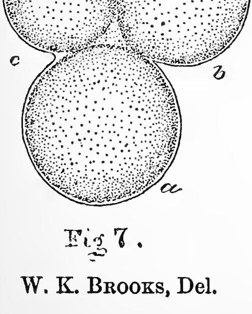


Fig 7.

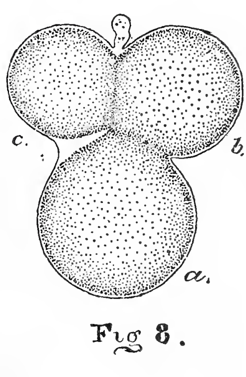


Fig 8.

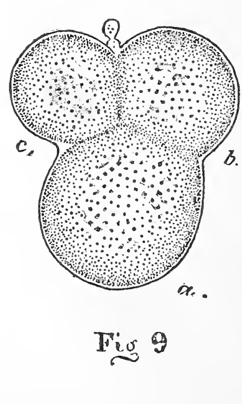


Fig 9

W. K. Brooks, Del.

PLATE II.

Figure 10.—The same egg one minute later. The line between the second micromere and macromere has disappeared, and the first micromere, *c*, now projects from one end of the elongated mass formed by the union of the spherules *a* and *b*.

Figure 11.—The same egg three minutes later. The fusion of *a* and *b* is now complete, and a large transparent vesicle is now visible in the first micromere, *c*, and another in the compound mass, *ab*.

Figure 12.—The same egg two minutes and thirty seconds later.

Figure 13.—Another egg, about two minutes later. This is the true resting stage, at the end of the second period of rest. The two vesicles have become irregular. The remains of an external membrane adhere to one side of the egg.

Figure 14.—The same egg seven minutes later than Figure 13. The compound mass, *a* and *b*, is elongated, the first micromere, *c*, is well defined, and waves travel from the nutritive towards the formative ends of the two masses. Two segmentation nuclei occupy the positions of the large vesicles of earlier stages. This stage is the beginning of the second period of activity.

Figure 15.—The same egg one minute later. The second micromere, *b*, is now well defined, as well as the first.

Figure 16.—The same egg one minute later. This stage marks the end of the second period of activity. The formative end of the egg is now occupied by four micromeres, two of which seem to be the products of the division of the first micromere, *c*, and two of them the products of the second, *b*.

Figure 17.—The same egg two minutes later, at the commencement of the third period of rest. The second micromere, *b*, has again begun to fuse with the macromere, *a*.

Figure 18. The same egg three minutes and thirty seconds later. The second micromere is no longer separated from the macromere, and mass, *a* and *b*, formed by their union is nearly spherical.

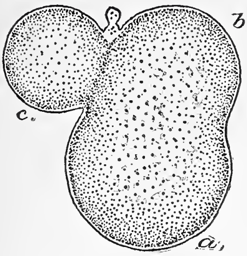
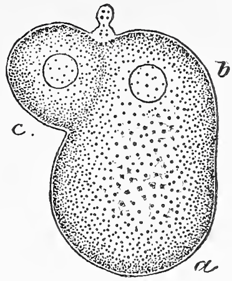


Fig 10.



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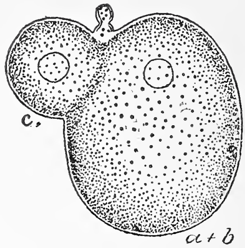


Fig 12

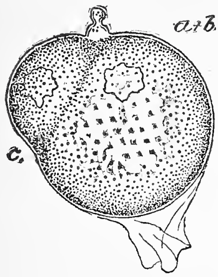
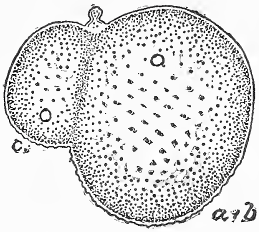


Fig 13



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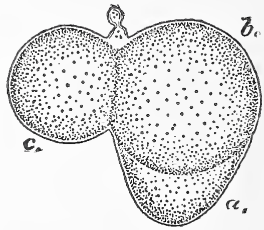


Fig 15

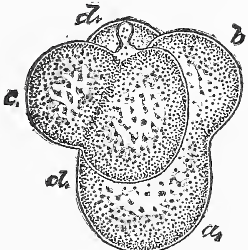


Fig 16.

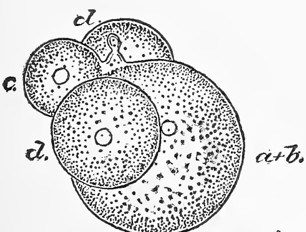


Fig 18.

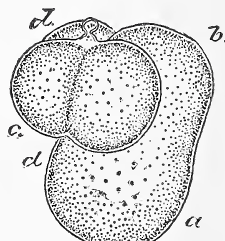


Fig 17.

W. K. Brooks, Del.

PLATE III.

Figure 19.—The same egg two minutes and a half later, at the end of the third period of rest, viewed at right angles to Figure 18.

Figure 20.—The same egg thirteen minutes later, and in the same position as Figure 18. The spherule, *c*, of Figure 19, has divided into two, and the second micromere, *b*, has become prominent, so that there are five micromeres at the formative pole.

Figure 21.—The same egg one minute later, and in the same position as Figure 19.

Figure 22.—The same egg in the position of Figure 20, fifteen minutes later than Figure 21, and in the fourth period of activity. There are now seven micromeres at the formative pole, six on one side of the polar globules and one, the second micromere, *b*, on the other.

Figure 23.—The same egg twenty-one minutes later, viewed from the side opposite the second micromere. The cells which have been formed by the division of the micromeres of the stage 19, now form a layer, the ectoderm, which rests, like a cap, on the macromere, *a*.

Figure 24.—The same egg five hours and fifteen minutes later, in the same position as Figure 22, but not quite as much magnified. On one side the polar globule is still separated from the macromere, *a*, by a single spherule—the second micromere, *b*. Opposite this the growing edge, *g*, of the ectoderm is spreading still farther down over the macromere. At the point *g*, and at four other points, are pairs of small cells, which have evidently been formed by the division of the larger spherules.

Figure 25.– Another egg at about the same stage.

Figure 26.—The egg shown in Figure 24, fifty-five minutes later. The macromere, *a*, is almost covered by the ectoderm, and the second micromere, *b*, has divided into a number of spherules. At the growing edge, *g*, an ectoderm spherule is seen separating from the macromere.

Figure 27.—A similar view of an egg twenty-seven hours after impregnation. The macromere is almost covered by the ectoderm, *ec*, and is not visible in a side surface-view. At *g* is an ectoderm spherule, which is separating from the macromere.

Figure 28.—Optical section of the same egg; *ec*, ectoderm; *en*, macromere, divided into two spherules. No segmentation cavity can be seen in a normal egg at this or any of the preceding stages.

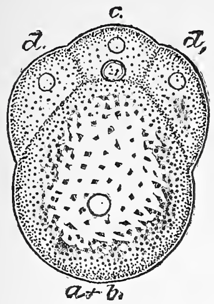


Fig 19

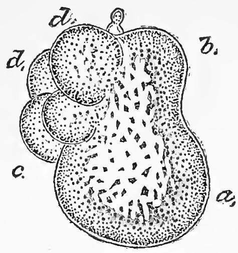
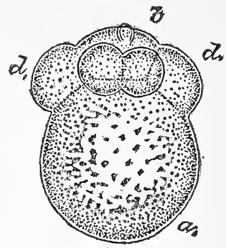


Fig 20.



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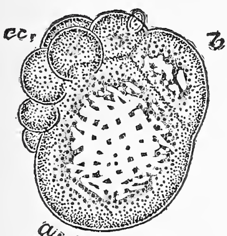

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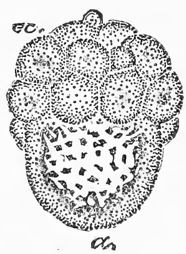
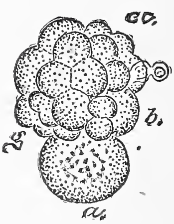


Fig 23



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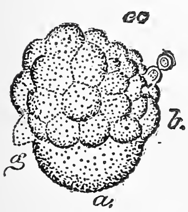

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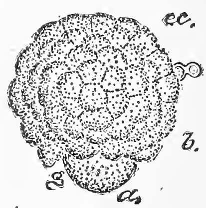

Fig 26.

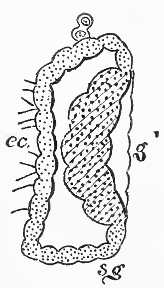

Fig 31.

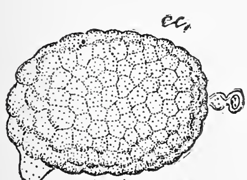

Fig 27

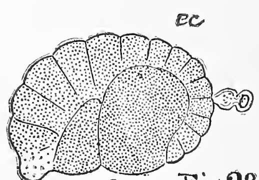

Fig 28.

W. K. Brooks, Del.

PLATE IV.

Figure 29.—View of the nutritive pole of an egg a few hours older.

Figure 30.—View of the formative pole of a still older egg.

Figure 31.—Optical vertical section of a somewhat older egg, figured with the polar globule above and the ectoderm to the right. The egg is now flattened from above downwards, and is disc-shaped in a surface view. The macromere has given rise to a layer of larger granular cells, which are pushed in so as to form a large cup-shaped depression. The more transparent ectoderm, *ec*, now carries a few short cilia scattered irregularly, and the two layers are separated from each other by a segmentation cavity. This figure is in Plate III.

Figure 32.—Surface view, and

Figure 33.—Optical section of the embryo at the first swimming stage. The ectoderm has folded upon the endoderm, so as to form a primitive digestive cavity, with an external opening, *g*. The cilia of the velum have now made their appearance around the area occupied by the polar globule. This was not present in the egg from which the figure was drawn, but it was seen in other eggs, and is shown in a later stage of another embryo, Figure 36.

Figure 34 and Figure 35.—Two surface views of the embryo shown in Figure 32.

Figure 36.—An older embryo, in the same position as Figures 32 and 33. The external opening of the primitive digestive tract has closed up, and the two valves of the shell have appeared in the place which it had occupied. The endoderm has no connection with the exterior, and no central cavity could be seen.

Figure 37.—A somewhat older embryo, figured with its dorsal surface above. There is a large, central, ciliated digestive cavity which opens externally by the mouth, *m*, which is almost directly opposite the primitive opening, the position of which is shown by the shell, *s*.

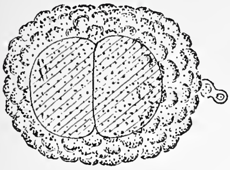

Fig 29.

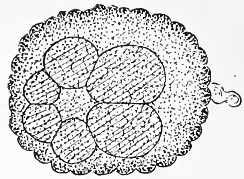

Fig 30

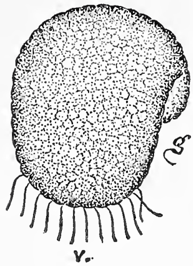

Fig 34.

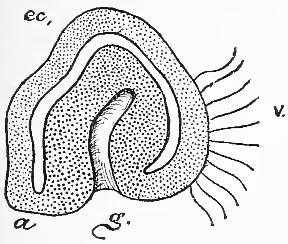

Fig 33.

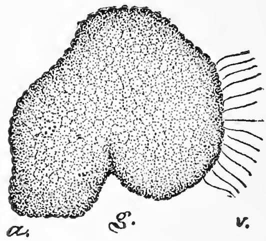

Fig 32.

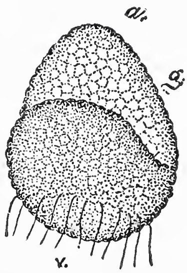

Fig 35.

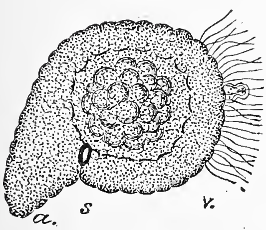

Fig 36.

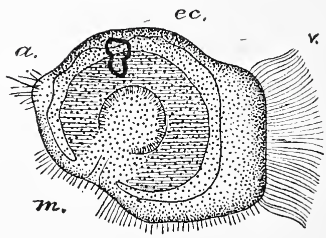

Fig 37.

W. K. Brooks, Del.

PLATE V.

Figure 38.—A similar view of a still older embryo. The shell, *s*, has increased in size, and the digestive tract has two openings, the mouth, *m*, and the anus, *an*, which are very near each other on the ventral surface.

Figure 39.—The opposite side of a still older embryo, in which the body-wall begins to fold under the shell, to form the mantle, *m*.

Figure 40.—Dorsal view of an embryo at about the same stage.

Figure 41.—Dorsal view of an embryo at the stage shown in Figure 38, with its valves extended; *rs*, right valve of shell; *ls*, left valve of shell; *an*, anus; *a*, anal papilla; *ma*, mantle; *v*, velum; *b*, body-cavity; *st*, stomach.

Figure 42.—View of left side of a still older embryo; *i*, intestine. Other letters as in Figure 41.

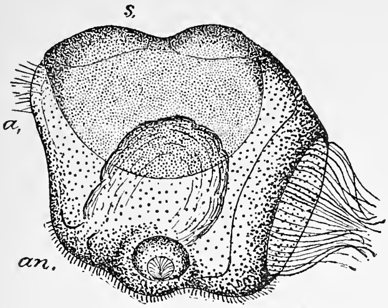

Fig 38

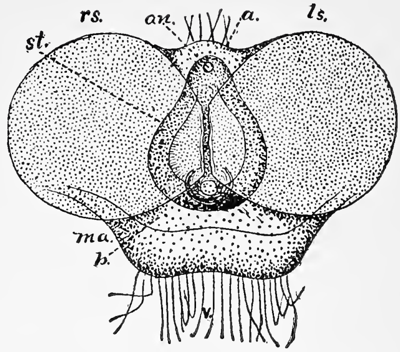

Fig. 41

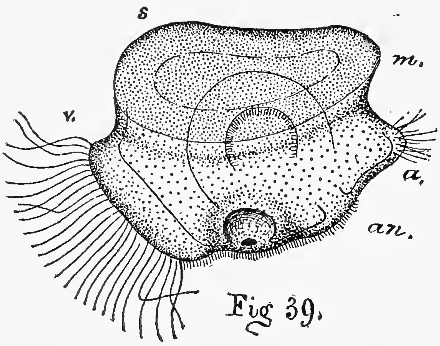

Fig 39.

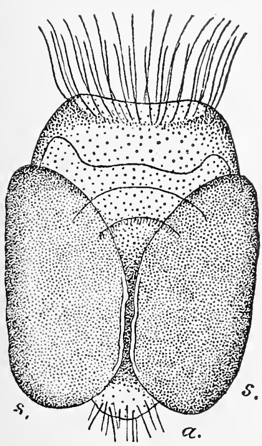

Fig 40.

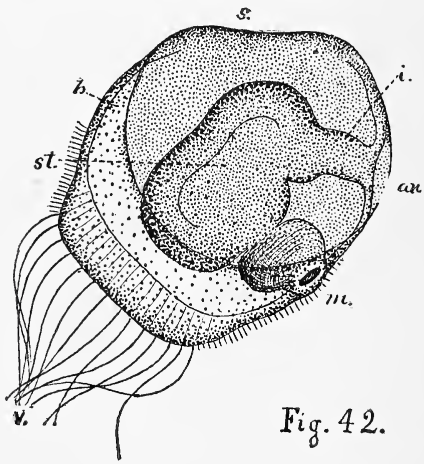

Fig. 42.

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PLATE VI.

Figure 43.—Dorsal view of an embryo six days old, swimming by the cilia of its velum.

Figure 44.—View of right side of another embryo at the same stage; *mu*, muscles; *l*, liver. Other letters as in Figure 41.

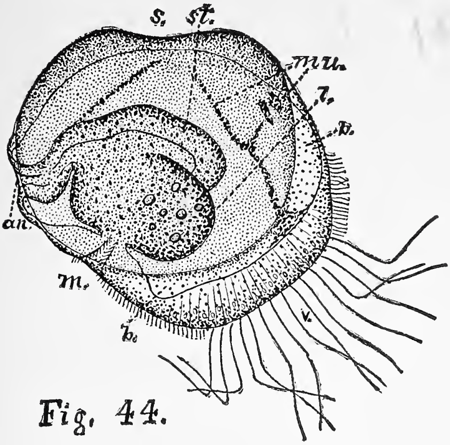

Fig. 44.

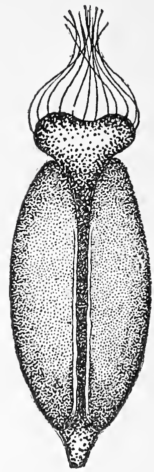

Fig 43.

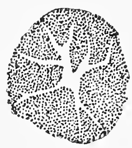

Fig. 47.

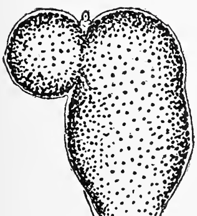

Fig. 46.

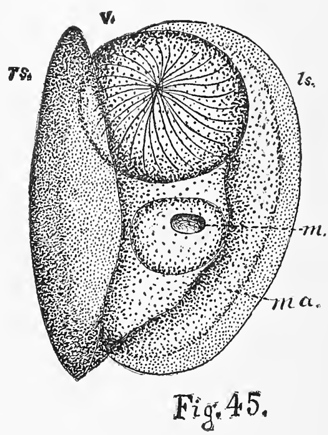

Fig. 45.

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PLATE VII.

Figure 48.—The seminal fluid of a ripe male oyster, mixed with water, and seen with a power of 80 diameters. Zeiss. a. 2.

Figure 49.—Fluid from the ovary of a ripe female oyster, seen with the same magnifying power.

Figure 50.—Seminal fluid of a ripe male oyster, magnified 500 diameters.

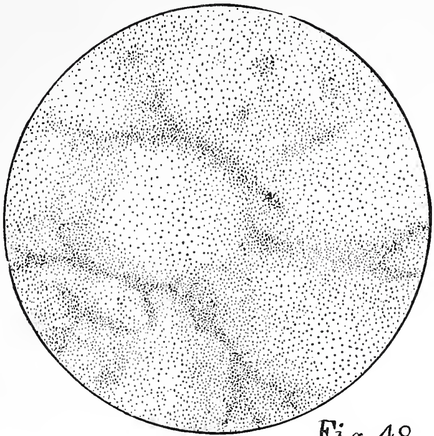

Fig. 48.

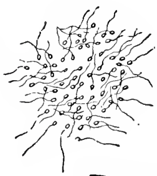

Fig. 50.

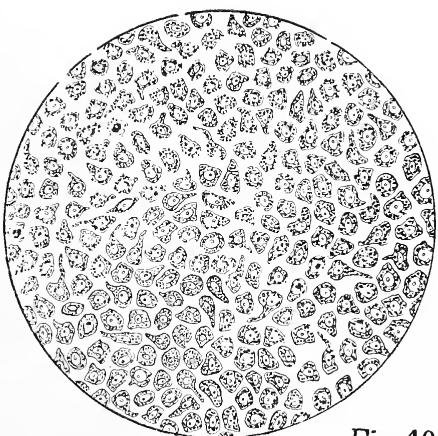

Fig. 49.

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PLATE VIII.

Figure 51.—Egg a few minutes after mixture with the male fluid magnified 500 diameters.

Figure 52.—Egg about thirty minutes after fertilization magnified 500 diameters.

Figure 67.—Section of a portion of the visceral mass of a male oyster magnified 250 diameters. The surface epithelium of the body is shown at the lower end of the figure. Above this is a loose, thick layer of wrinkled cells, which have the appearance of adipose cells from which all the fat has been removed. Above this layer is a large duct, lined with epithelial cells, and filled with ripe spermatozoa, which have been poured into it from two follicles which communicate with it on each side. Above this are sections of a number of the follicles of the testis, in three of which the contents are figured

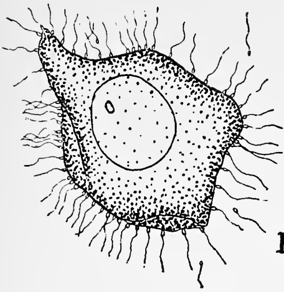

Fig 51.

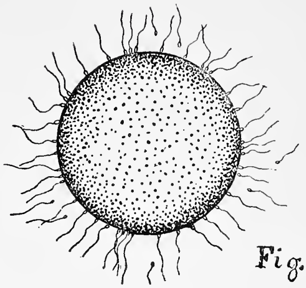

Fig. 52.

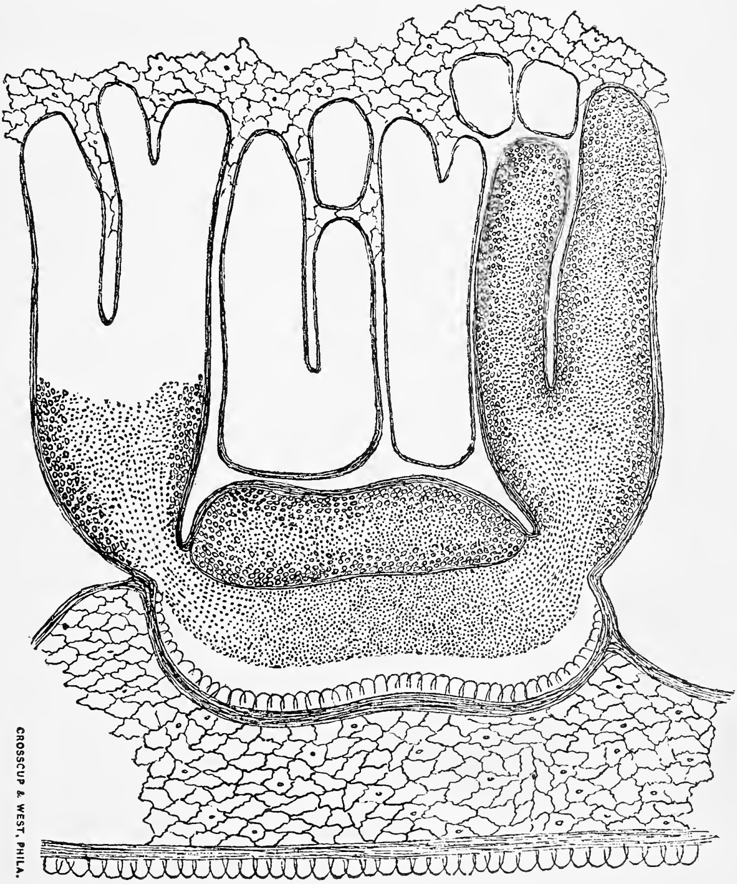

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Fig. 67.

PLATE IX.

Figure 53.—Section of a portion of the viscera mass of a female oyster magnified 250 diameters; *a*, epithelium of the surface of the body; *b*, layer of connective tissue; *c*, layer of wrinkled cells, which are probably fat cells, from which all the fat has been removed; *f*, sections of ten ovarian follicles; *e*, the ovarian eggs.

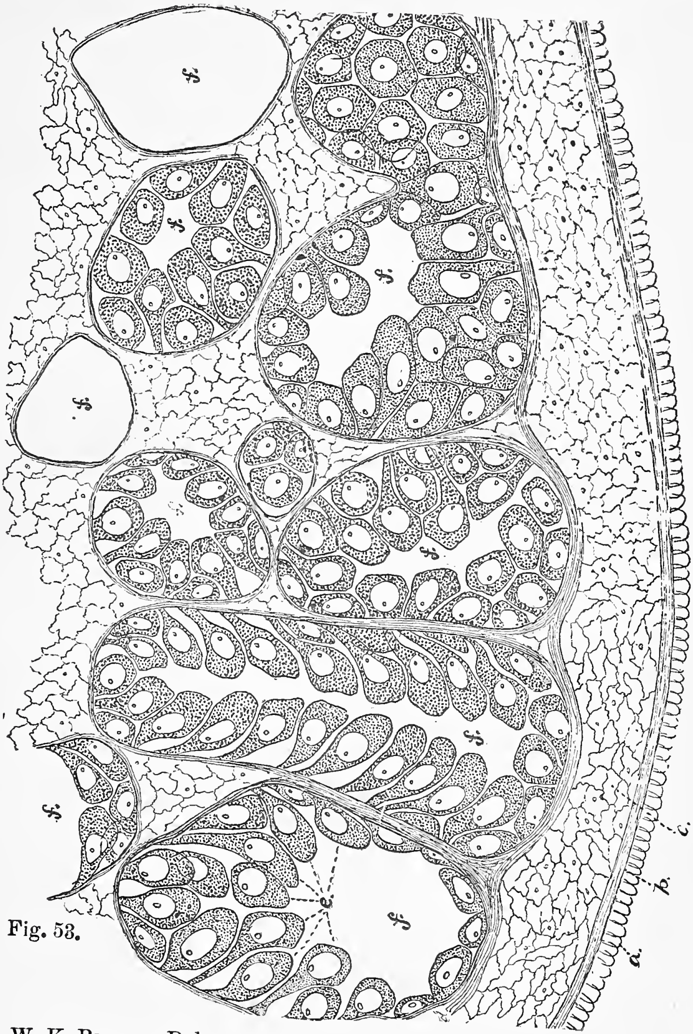

Fig. 53.

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PLATE X.

Figures 54–66.—Abnormal or direct form of segmentation.

DEVELOPMENT OF THE OYSTER. Plate X.

54.

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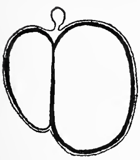
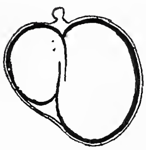
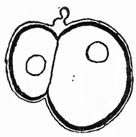


60.

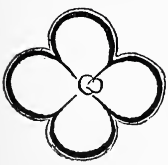


61.

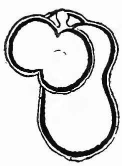


62.

63.



64.



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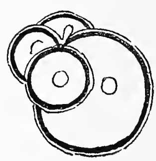


66.

W. K. Brooks, Del.

EXTRACTS FROM REPORT

OF

Francis Winslow,

Master U. S. Navy, Assistant Coast and Geodetic Survey,
Commanding Schooner Palinurus,

MADE TO

CARLILE P. PATTERSON,

Superintendent Coast and Geodetic Survey,

OF

INVESTIGATIONS OF THE OYSTER BEDS IN TANGIER AND POCOMOKE SOUNDS AND PARTS OF THE CHESAPEAKE BAY, CONDUCTED DURING PORTIONS OF THE YEARS 1878 AND 1879.

PART I, 1878.

These extracts, containing information valuable to the people of Maryland, are published by permission and through the courtesy of the Superintendent in charge of the Coast and Geodetic Surveys.

PART I.

Report of Investigations Made from August 21st to October 14th, 1878.

TANGIER AND POCOMOKE SOUNDS.

The charts showing the oyster beds and limits of oysters in these Sounds have been constructed from the *data* collected during the progress of the work.

Only the natural beds are shown on them, and no attempt was made to carry the investigation beyond the Sounds, except in the cases of the Manokin and Big Annemessex Rivers, where the beds were large enough to make their delineation and study advisable.

The beds have been named from the solid "rocks" which they surround, and are indicated on the charts by the darkest shades. In many cases it was a matter of some difficulty to determine the outlines of the beds proper, on account of their peculiar formation.

It would have given an erroneous impression to have considered either the solid unbroken portions as the beds, or to have taken the entire area upon which oysters are found, and I have therefore adopted a proportion of 0.1 oysters to the square yard as the standard by which to determine the outlines, all positions where the proportion fell below that standard being excluded from the beds, unless other circumstances have led me to a different decision.

The light shades on the charts show the area covered by scattered oysters, and as already explained, must be considered only approximate. The broken lines show areas where the oysters are very widely separated. The dark blue lines

have been drawn through those positions where the proportion of oysters to the square yard was above the average.

In designating the oysters, the term "young growth" has been applied to the small oysters that were evidently but one year or one and a half years old. The term "young" has been applied to small oysters of the last brood that were found clinging to the mature and old shells and were, on an average, about one-half or three quarters of an inch in length, or under.

Tangier Sound extends north and south, in round numbers, thirty-six miles, from Watts' Island to the head of Fishing Bay and each side of the channel for thirty-two miles is lined with oyster beds of greater or less extent. These beds are continued, though the oysters are generally scattered, through Kedge's, Hooper's and Holland Straits and on the shoal between Smith's and Tangier Islands. On each side of the channels into the Nanticoke, Manokin and Big Annemessex Rivers, beds are found and to a less extent in the Wicomico and Little Annemessex Rivers.

By reference to the chart, it will be seen that the only parts of the Sound unoccupied by oysters are a short space, one mile in length, off Deil's Island; a space of two miles north of Jane's Island Light and between the Big and Little Annemessex Rivers and a stretch of two and a half miles on the western side of the Sound off Reach Hammock and the northern part of Tangier Island.

With these exceptions, the oysters are to all intents, continuous and the total area covered by them amounts to 69,127 square nautical miles.

The area of the beds proper or that part of the total area on which the proportion of oysters to the square yard was at least 0.1, is 17,976 square nautical miles.

Whenever the names of the beds could be ascertained they have been given to them but in some cases they could not be and I have included them under general heads.

Taking them from the head of Fishing Bay in regular order, they are twenty-eight in number.

* * * * * * *

DENSITIES.

Specimens of the bottom water taken on each bed, at all stages of the tide, have been tested with the hydrometer and its readings reduced to a standard temperature of 60 degrees Fah. These results show a maximum density of the waters of Tangier Sound of 1.0164, which was found in the lower part, about the California Rock, at half flood tide. The minimum density of 1.0111 was found in the upper part of Fishing Bay, with the tide three quarter ebb. The following table shows the maximum and minimum density on each bed, with state of tide and remarks:

COMPARISON OF DENSITIES—TANGIER.

The figures represent the excess of Density over that of Distilled Water, which is represented as 1.000.

Bed.	Max. Density.	Tide.	Remarks.	Diff.	Min. Density.	Tide.	Remarks.
Fishing Bay	1.0136	H. W.	Southern part.	.0025	1.0111	$\frac{1}{4}$ & $\frac{3}{4}$E.	Extreme Northern part.
Were Point	1.0139	$\frac{1}{2}$Fl.	In Chan. to Hooper's Sts.	.0022	1.0117	L. W.	
Shark's Fin	1.0143	H. W.	Edge of Main Channel.	.0025	1.0118	$\frac{3}{4}$E.	Middle of Bed.
Nanticoke M. G	1.0136	H. W.	West of Channel.	.0017	1.0119	$\frac{1}{2}$E.	Middle of Bed.
Clump Pt	1.0118	$\frac{3}{4}$Fl.	Only one specimen.	....	....	....	No specimen.
Horsey's Bar, Tyler's Rock, Drumming Shoal	1.0132	$\frac{1}{4}$E.	Only one specimen.	.0012	1.0120	$\frac{1}{2}$Fl.	Only one specimen.
Grass Tangier	1.0144	$\frac{1}{4}$Fl.	In the Channel.	.0024	1.0120	L. W.	Middle of Bed.
*Turtle Egg Rock	1.0120	$\frac{1}{4}$Fl.					
Chain Shoal	1.0145	$\frac{1}{4}$Fl.		.0022	1.0123	$\frac{3}{4}$Fl.	
Mud Rock	1.0144	$\frac{3}{4}$Fl.		.0008	1.0136	$\frac{3}{4}$E.	
Muscle Hole	1.0157	$\frac{1}{4}$E.		.0012	1.0145	L. W.	
Piney Island Bar	1.0150	$\frac{1}{2}$E.	South of Beds.	.0019	1.0131	$\frac{1}{2}$E.	Middle of Bed.
Manokin River	1.0152	$\frac{1}{4}$E.	Lower Beds	.0014	1.0128	$\frac{1}{2}$E.	Upper Beds.
Big Annemessex	1.0151	H. W.	Western Beds.	.0007	1.0144	$\frac{1}{2}$E.	Eastern Beds.
Harris Rock	1.0153	$\frac{1}{4}$E.	Southern Beds.	.0007	1.0146	H. W.	
Terrapin Sands	1.0159	$\frac{3}{4}$E.	Strong Southerly Winds.	.0015	1.0144	$\frac{1}{2}$Fl.	Light Southerly Breezes.
Rock off Jane's Island	1.0156	$\frac{1}{2}$E.		.0013	1.0143	$\frac{3}{4}$Fl.	
Great Rock	1.0159	$\frac{1}{4}$Fl.		.0011	1.0148	H. W.	
Woman's Marsh	1.0160	$\frac{3}{4}$E.	Opposite opening between Tangier & Smith's Isl.	.0016	1.0144	$\frac{3}{4}$Fl.	
Little Thoroughfare	1.0158	$\frac{3}{4}$E.		0009	1.0151	$\frac{1}{2}$Fl.	
Great Thoroughfare	1.0157	$\frac{1}{2}$F.$\frac{3}{4}$E.		.0005	1.0152	$\frac{1}{2}$Fl.	
California	1.0164	$\frac{1}{2}$Fl.		.0012	1.0152	$\frac{3}{4}$Fl.	
Johnson's Rock	1.0161	$\frac{1}{2}$Fl.		.0013	1.0148	$\frac{1}{2}$E.	
Oak Hammock	1.0160	$\frac{1}{4}$E.		.0002	1.0158	$\frac{1}{2}$E.	

* All specimens taken on Flood. This is Minimum Density.

By consulting the table, it will be seen that the state of the tide has but little influence upon the density, though the depth of the water has and the prevalence of strong winds may increase or diminish it. There is shown a gradual and constant increase of density as the southern portion of the Sound, where it opens upon the Chesapeake, is approached.

There is also an increase of density when in the vicinity of the openings into the Bay and a decrease in the various rivers and off their mouths.

Though the density of the water increases, yet the difference between the maximum and minimum densities steadily decreases to the southward, showing that the oysters on the northern beds are exposed to greater fluctuations of density, and probably salinity, than those on the beds to the southward.

There were no heavy rains during my stay in the Sounds and the densities given therefore show only the condition of the water in that respect during dry weather. I was informed that there was a noticeable change in its character about the mouths of the tributaries of the Sounds, after a heavy rainfall and the effect upon the oysters was also perceivable.

The difference between the maximum and minimum densities of the Sound amounts to 0.0053; but the difference between the maximum and minimum densities on each bed will give a more correct idea of the changes to which the oysters are exposed. The greatest difference is 0.0025, which takes place over the Shark's-Fin and Fishing Bay beds and the least difference over any of the main beds is that on the Little Thoroughfare, which amounts to 0.0009.

It would be perhaps still more correct to divide the Sound into several parts and consider the fluctuation of densities over them thereby assembling a larger number of observations.

Throwing out the Fishing Bay beds, which by their position are removed to a great extent from the conditions affecting the other beds and including all those south of Clay Island as far as Piney Island Bar, when the influence of the Manokin and Annemessex Rivers would be felt, the difference of density amounts to 0.0028.

The difference of density over the beds south of Little Island and north of Little Annemessex River is 0.0031.

The difference of the beds south of Jane's Island Light is 0.0020.

These differences show that the greatest fluctuation is over the beds in the middle of the Sound and is probably due to the influence of the Big Annemessex and Manokin Rivers and the waters entering by Kedge's Straits.

Throughout the Sound there is a marked difference between the densities of the water taken about the latter part of August and the first part of September and those taken in October.

This difference is given in the following table:

Bed.	Date First Observat'n.	Date Second Observat'n.	Difference in Density.	Bed.	Date First Observat'n.	Date Second Observat'n.	Difference in Density.
Fishing Bay............	Aug. 24	Oct. 5	.0018	Manokin Bed..........	Aug. 27	Sept. 30	.0017
Were Point............	24	5	.0014	Harris' Rock	29	Oct. 1	.0005
Nanticoke Middle Gr'd.	26	5	.0014	Great Rock......... ...	30	Sept. 28	.0007
Bed N. of Turtle Egg Is.	26	4	.0016	Woman's Marsh.	30	23	.0008
Chain Shoal...........	27	8	.0011	Great Thoroughfare....	Sept. 5	28	.0007
Piney Island Bar.	28	4	.0010	California..	6	26	.0009
				Johnson's Rock........	6	20	0010

It will be seen by the table that the observations were made at from two weeks to six weeks apart; that generally speaking, the amount of difference in the densities increases with the interval between the observations and that the northern beds and those in the rivers are exposed to greater fluctuations of density than the neighboring ones in the Sound.

If the change of density over the beds as shown by these tables, represents with approximate accuracy the change of salinity of the water, the fluctuation is too slight to seriously affect the beds or oysters but if the slightness of the change is due to organic matter held in solution by the waters of the ebb-tide, which would replace the salt of the flood, there may

be a much greater difference in the salinity of the flood and ebb than has been indicated by the hydrometer.

CURRENTS.

The general set of the currents in the Sound is north and south, following the main channel and diverging slightly about the mouths of the tributaries and straits.

The arrows on the chart show the direction and the letters and figures the state of the tide and velocity per hour, in miles and tenths, at such stations as are preserved in the record.

The influence of the wind has not been eliminated, and accounts for many irregularities, both of velocity and direction.

About slack water, especially of the windward tides, this influence was most apparent.

In Fishing Bay the currents follow the general bend of the shores and channel, setting over the lower portion, on the flood, to the northward; over the middle portion to the northward and westward, as far as Fishing Point and above that point and over the upper part of the bay, setting to the northward and eastward.

The maximum observed velocity of the flood current was 0.38 of a mile per hour.

The ebb in each portion of the bay sets in an opposite direction to the flood.

The currents about the northern part of the Were Point bed were measured during and after strong northeast winds, which accounts for the set to the southward and westward, and also for the slight velocity of the ebb, which was only 0.15 of a mile per hour, the northeast wind having lasted for two days and having driven a good deal of the water out of Fishing Bay.

Over the Shark's Fin the flood current sets to the northward and the ebb to the southward and eastward, most of the latter apparently coming from Hooper's Straits.

Its maximum velocity was 0.4 of a mile per hour. The observations of the strength of the flood current made on this bed, were too much influenced by the wind to be considered

reliable but the velocity immediately south of the bed was 0.5 of a mile per hour.

The currents of the Nanticoke channel and over the adjacent beds, set to the northward and eastward on the flood, following the bend of the channel, with a maximum velocity of 0.6 of a mile per hour.

The ebb over the major portion of the Middle Ground sets to the southward, with a velocity of 0.3 to 0.4 of a mile per hour on the first quarter, until it meets the current of the Wicomico, when it turns to the westward.

A strong current sets in and out of Rock Creek; over the Drumming Shoal and Cedar Rocks, the current sets N. N.E. on the flood, with a velocity of 0.4 of a mile per hour and S. S.W. on the ebb tide, with a velocity of 0.6 of a mile per hour.

Over the beds south of the Shark's Fin and Cedar Rock, and north of Piney Island Bar and Kedges Straits, the general set of the flood is to the northward, with an inclination towards Holland's Straits, when about Turtle Egg Island, and tending to the northward and westward off the Little Thoroughfare. The general set of the ebb while in the channel is to the southward, but on the Turtle Egg Island, Mud and Muscle Hole Rocks the set is to the southward and eastward.

The strength of these and all currents in the Sound is much influenced by the winds that have prevailed during the immediately preceding days and which it was impossible to eliminate in the space of time covered by this investigation.

Over the western beds, above Kedges Straits, the maximum observed velocity of the flood was 0.8 of a mile per hour, and a mean of all the velocities of the flood current was 0.4 of a mile per hour.

The maximum observed velocity of the ebb current was 1.0 mile per hour, and the mean of all velocities of the ebb was 0.3 of a mile per hour.

Over the Chain Shoal the maximum velocity of the flood was 0.37, and the mean velocity was 0.3 of a mile per hour.

The maximum velocity of the ebb was 1.0 mile and the mean velocity 0.5 of a mile per hour.

The flood current over Piney Island Bar sets N. N.W., or about in general line with the sound at that point. Its velocity on the third quarter, during and after northerly breezes, was 0.1 of a mile an hour, and probably it is seldom less than that.

The ebb current over the northern part of the bed sets S. S.E., but tends to the southward over the southern part.

The maximum velocity of the ebb during and after northerly breezes was 1.00 mile per hour, and the mean of all observations, taken under similar circumstances, gives a velocity of 0.4 of a mile per hour.

In the Manokin River the current follows the general trend of the channel, the flood setting to the northward until above Hazzard's Point, and then to the northward and eastward.

The ebb sets southwest, and, when it strikes the shoal off Piney Island, curves somewhat to the southward.

The currents shown on the chart were measured during light or gentle northeasterly breezes.

The maximum velocity of the flood was 0.4 of a mile per hour, and the mean of all the velocities of the flood 0.2 of a mile per hour.

The maximum velocity of the ebb was 0.5 of a mile per hour, and the mean velocity 0.2 of a mile per hour.

In the Big Annemessex River the current sets to the eastward on the flood tide, and to the westward on the ebb, curving to the southward on the latter as it approaches the mouth of the river.

The maximum velocity of the flood current was 0.4, and the mean velocity 0.25 of a mile per hour.

Of the ebb the maximum velocity was 0.5 and the mean velocity 0.33 of a mile per hour. The flood current sets over Harris Rock to the northward, with a maximum velocity of 0.33, and a mean velocity of 0.2 of a mile per hour. The ebb being somewhat influenced by the current out of the Annemessex and the sweep of the main current of the Sound sets to the southward and westward, with a mean velocity of 0.2 of a mile per hour. The maximum velocity observed was but a slight increase of the mean.

Over the Terrapin Sands the flood sets northwest, with a maximum velocity of 0.9 and a mean velocity of 0.7 of a mile per hour. The ebb sets southeast until near the buoy marking the shoal, where it turns to the southward. Its maximum velocity was 1.0 mile, and its mean velocity 0.9 of a mile per hour. The currents over the Terrapin Sands were measured during spring tides, and after light breezes and calms had prevailed for several days. Over the Woman's Marsh Rocks the flood sets about N. N.W., until in the vicinity of Horse Hammock, where it turns to the northward and eastward. The ebb sets S. S.W. over the upper part of the bed, and to the southward and eastward over the lower. There is a strong set in and out of the opening between Tangier and Smith's Islands.

The maximum velocity of the flood was 0.7, and the mean velocity 0.6 of a mile per hour. The velocity of the ebb was, maximum 0.8, and mean 0.4 of a mile per hour. These currents were also measured during spring tides.

Along the eastern side of the Sound, below Jane's Island Light, and over the several beds located on the eastern edge of the channel, the general set of the current is to the northward on the flood and to the southward on the ebb. The flood sets a little to the eastward or westward of north as the channel changes in direction, and about the northern part of the Great Rock sets strongly to the northward and eastward into the Little Annemessex. The ebb current out of that river forms a strong tide rip where it joins the main current due east of Jane's Island Light and on the northern part of the bed off that light.

The general set of the ebb is the reverse of that of the flood, and both currents follow the trend of the channel.

Through the Thoroughfare, opposite the California Rock, the flood sets east into Pocomoke on the first three quarters, and west on the last quarter.

On the ebb the set is westward on the first three and eastward on the last quarter, and this irregularity is communicated, to some extent, to the waters over the California Rock.

The maximum velocity of the flood current on the eastern

side of the Sound, below the Little Annemessex, was 0.3, and the mean velocity was 0.2 of a mile per hour. The maximum of the ebb was 0.8, and the mean 0.7 of a mile per hour. Most of these currents were measured during northerly winds, which would increase the ebb and diminish the flood currents, and probably they are more equal than the observations show them to be.

Over the Oak Hammock Rocks the flood sets to the northward and westward, and the ebb to the southward and eastward, with a velocity of from 0.1 to 0.2 of a mile per hour.

Reviewing the currents, it will be seen that the strongest on both tides were those over Terrapin Sands during the spring tides, their velocity being about one mile per hour.

As the observations over the Sound were made during many various states of the weather and of tide, the highest velocity obtained is probably as great as ever sets over any of the beds.

The velocity within wide limits, however, is not so important to the oysters as the direction of the current, and that has been ascertained with, I hope, sufficient exactness to assist, so far as it can, in the study of the beds.

DEPOSIT.

It would require a much longer period of observation than was at my disposal, and a much more extensive and careful investigation of the character of the water and bottom of the Sound than I was enabled to make to allow me to speak with authority or exactness upon this subject; but from the information collected from the most intelligent of the oystermen, whose experience on the beds was considerable, I am of the opinion that there is little or no systematic deposit going on upon any of the beds of the main Sound.

There must be some sediment contained in the waters of the rivers and creeks, but it appears to be deposited on those beds near their mouths. In the upper part of Fishing Bay, on the Clump Point Rocks, Middle Ground of the Nanticoke, in the Manokin and Big Annemessex Rivers there is a larger amount of mud in the surface, and underneath, than else-

where in the Sound. Those beds lying in deep water are particularly free from an undue proportion of mud on the bottom, the shoalest beds having the thickest mud covering.

If there was a constant and increasing deposit upon the beds they would long ago have disappeared, or at least have become of much smaller area, but the reverse is the case, the beds increasing in area constantly.

They are, however, exposed to one species of deposit which is very injurious. Heavy gales occurring in winter and summer frequently tear up the large quantities of grass, seaweed and sponge on the sand shoals about the Sound and deposit it upon the beds. If this occurs in summer, when there are a smaller number of dredgers at work, the effect is very injurious, the "cultch" being covered, and the young, if spawned, smoothered by the grass, weeds, sand and mud which it collects. The California Rock, Piney Island Bar and Manokin beds are those most subject to this evil.

The gales also have the effect of covering the scattered oysters on the leeward sands, which process is called "sanding," and, from what I could learn, appears to be a very injurious one. The oysters are buried, and the bottom becomes smooth and hard. Where at least thirty bushels of oysters could be taken previous to a gale, not one oyster could be found subsequent to it.

The winter gales have the greatest effect, owing probably to their greater severity and direction, which is from the northward and westward. The "sand" oysters are found in largest numbers on the eastern shores of the Sound, and about Kedge's and Hooper's Straits, consequently they would feel a northwesterly gale much more than one from the opposite direction.

They are said not to recover from the "sanding" for several months, and upon their reappearance, are noticeable on account of the whiteness of their shells.

Though there were several very heavy blows while we were in the Sound, they were not of sufficient severity to produce the effect spoken of, and if they had been I should not have been able to detect it, on account of the shallowness of the

water in which the scattered oysters lie, which prevented the schooner's dredging for them.

EFFECT OF GALES AND ICE.

As there was no opportunity for me to investigate this question in person, the examination of the beds having been accomplished during the summer and autumn months, the following information is derived from the queries put to the oystermen and persons inhabiting the shores of the Sound.

The heaviest gales during the Winter season are from the northward and westward. During the summer season, from the southward, and southward and eastward. The gales from the eastward, southward and eastward, and southward, cause an increase of depth over all the beds, amounting sometimes to two feet, and the northerly and westerly gales a contrary effect, but not sufficient to leave any of the natural beds uncovered, except one or two small patches in Fishing Bay.

Gales from any direction cut away the leeward shores and points considerably, especially when they are of a sandy nature

Those parts of the Sound suffering most in this respect are Bishop's Head, Haines' Point and Diel's Island, Little Island, the shores about and near Jane's Island, Great Fox Island, the shores about Horse Hammock, and the southern part of Watts and Tangier Islands.

Cod Harbor, in Tangier Island, is said to be filling up with the washings of the sand-spit to the southward.

Though it is said the amount washed away from these points is considerable, no additional deposit was ever noticed on the beds, nor did the gales appear to affect them in any way other than has already been described, except in conjunction with the ice in the winter. Ice never rests upon the main beds except in a few isolated cases where there happens to be a very shoal spot on the bed.

Occasionally the ice will ground on some of the small rocks in Fishing Bay and once in a while on the Woman's Marsh Rocks but not often.

The injury done the oysters by the grounding depends upon the length of time the oysters are in contact with the ice.

If it only touches in a few places not much harm is done; indeed, it is supposed to protect the majority on the bed by covering them, but where there is a contact all over the "rock," the oysters are killed in a short space of time.

The number of points in the Sound where it is possible for the ice to rest is very inconsiderable, and not many of the animals are destroyed by the grounding of the ice, though they are affected seriously by its long continued presence.

The winter gales break up the ice fields and pile them up in immense masses on the leeward shores and over the adjacent beds. The Shark's Fin bed suffers particularly in this respect. A good deal of damage is done to the shores by the ice and the oysters feel the effect, showing it by becoming what is called "Winter-killed," or poor and weak, having a slimy, sickly appearance when opened.

Many die on the beds from this cause and after the disappearance of the ice, ten days or two weeks must elapse before they are fit for marketable purposes.

Ordinary cold weather and a moderate amount of ice is said to improve the fishing, the oysters appearing to be drawn more to the surface of the bed, and the shells to sink more toward the bottom. My informants said this effect was quite noticeable.

No one that I was able to interrogate had ever seen an oyster frozen *in the water*, and the impression was that so long as the oysters were covered they would recover from any ill-effects of ice or ordinary cold weather.

POCOMOKE SOUND.

Pocomoke Sound extends from Watts' Island, in a north northeasterly direction, twelve and a half miles.

The main channel is narrow with a varying depth of water, the main body of the Sound being covered by shoals with from seven to eighteen feet of water over them.

Long sand-spits make off from most of the points and islands and separate the channels into the different creeks from each other.

The Sound is about nine and a half miles broad from shore

to shore about its middle, but the channel occupies only one and a quarter miles of this space.

The change of depth is gradual, except between Watts' and Beach Islands, near the southern extremity of the Sound, where the change from deep to shoal water is sudden. About the upper and northeastern portion the depth is more uniform, the deep channel shoaling to about twelve feet, and that water being but slightly diminished close to the shores.

The beds do not as in Tangier Sound, cover the shoals on each side of the channel, the majority being found on the eastern side. Only two beds are to the westward of that part of the channel, where the water is deeper than three or four fathoms.

The total area covered by oysters to a greater or less extent in this Sound, is 34.118 square nautical miles. This area is that enclosed on the chart by the boundaries of scattered oysters, and is but approximate, as previously explained.

The solid beds, comprising all parts of the Sound where oysters were found in a greater proportion than 0.1 to the square yard, or where the bed was found to be to all intents, solid "oyster-rock," or comparatively unbroken, contains a total area of 4.519 square nautical miles.

The groups or rocks are not always contiguous, being separated by the channels into the different creeks and rivers and by mud-sloughs and spaces.

In only one case have the beds extended across the channel, and peculiar circumstances account for that exception.

Generally speaking the beds will be found to lie on each side of the main channel in the Sound and on each side of the channels into the rivers. Taking them in order from the mouth of the Pocomoke River to the entrance to the Sound, there are seventeen of a sufficient size to justify a separate consideration and name.

I have called them by the names given by the local oystermen to the solid "oyster-rock," which was probably the origin of the bed.

They are: The Old Rocks and New Plantation Rocks, Buoy Rock, Potter's Rock, Slatestone Flat Rock, Dog-Fish

Rock, Drum-Bay-Point Rock, Trevise's Rock, Shell Rock, Buoy Spit Rock, Muddy Marsh Rocks, Bird Rocks, Hern Island Rock, Beach Island Rock, Parker's Rock, and Brig Rock.

In considering and describing the beds I shall separate the first ten from the others and as they are subjected to very similar conditions of bottom, current, and density of water, shall treat them under one head, as the Pocomoke Rocks.

SCATTERED OYSTERS IN POCOMOKE SOUND.

The area covered by scattered oysters is only approximate, it being very difficult to accurately define the limits. Generally speaking the one fathom curve will nearly mark the inshore limit, while the soft muddy bottom of the main channel will define the outer one. The depth of water over the scattered oysters and the character of the bottom can be ascertained by reference to the chart. No oysters were found in the deep channels nor on the shoal sand spits.

The oysters are scattered singly and in groups, but usually grow singly, though numbers of small beds of a few hundred yards area are included within the limits of scattered oysters. In the vicinity of the Messongo and Guilford Creeks, the oysters seem to be scattered in that manner, the spaces between the groups being proportional to their sizes. Very few oysters are found along the edge of the shoal on the western side of the channel south of the Muddy Marsh. In the channel itself no oysters were found. Opposite Beach Island, in from thirteen to fourteen fathoms, a few clams and shells were brought up. In this case, however, the bottom was of hard sand.

The area covered, to a greater or less extent by the scattered oysters comprises 122,117.500 square yards, or 29.599 square nautical miles.

The proportion of oysters over this area, as near as I could ascertain, was about one hundred and seventeen thousandths to the square yard.

DENSITIES.

The density in the water over the different beds is given in the Record, Volume 1.

The least density found, that of 1.0113 was across the mouth of the Pocomoke River at low water of the spring tide.

The water of the greatest density, that of 1.0174 was taken from about the middle of the Sound, over the Bird, Buoy Spit, Muddy Marsh and Hern Island Rocks.

The density over the beds, therefore, would be within those limits, the variation amounting to 0.0061. The effect of the tide does not appear to be invariable, as the greater densities were found as frequently on the ebb tide as on the flood. The depth of water and the prevailing winds have probably a greater effect than anything else, as the density increases with the depth, and the prevalence of easterly or south easterly winds backing the waters of the Bay up into the Sound, would have a like effect.

As the variation noticeable during the space of eleven days, under various conditions of weather, were so small, it can hardly be much greater at any time, and unless much greater shown by the records if representing the change in salinity, can have but very little if any effect upon the oysters on the beds. By the following tables of comparison it will be seen that the fluctuation of density is, as in Tangier Sound, greatest at the head of the Sound and least at its entrance, with an increased fluctuation where the influence of the Messongo and Guilford Creeks are felt.

On the beds above the Bird Rock the difference of density noticed was 0.0061. On the remainder of the beds the difference was 0.0015, showing that there is a much smaller change in the density over the southern beds than over the northern.

DENSITY TABLE—POCOMOKE.

The figures show the excess of density over that of distilled water, which is represented by 1,000.

Bed.	Maximum Density.	Tide.	Remarks.	Difference.	Minimum Density.	Tide.	Remarks.
On and above Potter's and Slate Stone. . . .	1.0160	H.W. and $\frac{1}{4}$ E.		.0047	1.0113	L. W.	Section.
Shell Rock and above. . .	1.0170	$\frac{1}{4}$ Fl.	14 feet calms and light breezes several days.	.0014	1.0156	$\frac{3}{4}$ Fl.	5 ft. water.
Muddy Marsh.	1.0174	$\frac{3}{4}$ E.	18 ft and same as above	.0014	1.0160	$\frac{1}{4}$ Fl.	Strong easterly breezes.
Buoy Spit.	1.0172	$\frac{1}{2}$ Fl.	15 ft. and same as above	.0004	1.0168	$\frac{1}{2}$ E.	15 ft. light breezes.
Bird Rock and Hern Island Rock	1.0175	$\frac{1}{2}$ E.	4 fms. & same as above	.0015	1.0160	$\frac{3}{4}$ E.	18 ft. mouth of Guilford Creek.
Mesongo Creek.	1.0173	$\frac{1}{2}$ E.	17 ft. and same as above	.0007	1.0164	L. W.	Eastward Station 7. feet.
Guilford Creek.	1.0167	H. W.	9 ft. light breezes.	.0007	1.0160	$\frac{1}{2}$ Fl.	Head of Creek.
Parker's Rock	1.0172	$\frac{1}{4}$ E.	12 ft. light breezes.	.0009	1.0163	$\frac{1}{2}$ Fl.	Light breezes.
Brig Rock.	1.0169	$\frac{3}{4}$ Fl.	11 ft. light breezes.	.0005	1.0164	L. W.	17 ft. light breezes.

CURRENTS.

Over the Pocomoke beds the general set of the ebb current is westerly until it reaches the shoal between and south of Broad and Apes Hole Creeks, where it turns to the southward into the main channel.

The majority of the observations of the ebb current were made during moderate northeasterly breezes but the direction seems to have been but little influenced by them, though the strength probably was, as at high and low water by the tide tables, when there should have been no perceptible current, one was observed of from 0.1 to 0.2 of a mile an hour. The maximum strength observed was 0.5 of a mile per hour.

The flood current sets northeast over the beds and has a maximum strength of 0.5 of a mile per hour and is but very slightly influenced in direction by the wind.

In the main channel of the Sound below the Shell Rocks and over the Muddy Marsh Rocks, the flood current sets to the northward, following the general direction of the channel.

The maximum strength of this current, when uninfluenced by the wind, was 0.45 of a mile per hour.

No observations of the strength of the ebb current were made in the main channel but it is probably equal, or of slightly greater strength, than the flood and sets to the southward. Over the Bird and Hern Island Rocks the flood current sets to the northward and eastward into Messongo and Guilford Creeks, with a maximum velocity, when uninfluenced by the wind, of 0.24 of a mile per hour. The ebb sets to the southward and westward, curving to the southward as it becomes influenced by the main current, with a maximum velocity of 0.4 of a mile per hour.

North of the Guilford Flats the flood sets northeasterly toward Muddy Creek. The maximum velocity observed during light northerly breezes was 0.3 of a mile per hour. South of the Guilford Flats the current follows the general direction of the channel, the flood having a tendency towards Hunting Creek, where the channel into Guilford Creek joins the latter.

The maximum velocity observed during light northerly breezes was 0.5 of a mile per hour.

The ebb out of Messongo and Guilford Creeks sets to the southward and westward, following the channel until it reaches the Bird and Hern Island Rocks, where it curves to the southward. Its maximum velocity was 0.4 of a mile per hour. The current over the Brig and Parker's Rocks sets to the northward and to the southward; the maximum strength of the flood, when uninfluenced by the wind, was 0.24 of a mile per hour, but a moderate breeze appears to be sufficient to cause a marked increase of strength and change of direction.

Off the mouth of the Chesconessex, where the wind, though light, had the width of Chesapeake Bay and both Tangier and Pocomoke Sounds to sweep over, the flood tide on the third quarter had a set to the northward and eastward of 0.4 of a mile per hour. North of Parker's Rocks the flood, on the first quarter, during a moderate southwesterly breeze, was found to set to the northeast at a rate of 0.6 of a mile per hour.

The oystermen greatly overrate the strength of the currents in the Sounds, putting the maximum velocity at about four knots on the ebb and somewhat less on the flood; but I could find no reason that would explain so great an increase over the velocities as established by ourselves, and consequently doubt the value of the estimate.

DEPOSITS.

The fact that on nearly all the beds and especially those in the vicinity of the creeks and rivers and in the upper part of the Sound, there is a light covering of mud more or less thick over the oysters, would lead to an inference that there must be a deposit of that character going on.

On most of the beds the substratum of the bottom was hard and the thickness of the surface covering gradually decreased as the entrance to the Sound was approached.

In the upper part of the Sound shells were found with the

mud for several feet and of such a number and character, being old and discolored, as to forbid the supposition that they had recently sunk in the mud or been covered by it.

The Pocomoke River, draining an extensive tract of the Peninsula, would bring down a large amount of sediment, which the strong ebb current would carry directly over the beds in the upper part of the Sound. The set of the ebb is east, and as will be seen by the chart, the deeper water lies nearest the southern shore of the upper Sound, and those beds lying to the southward of the channel are the hardest and least broken.

The shores are low and marshy and probably add somewhat to any sediment held by the main current before it enters the Sound.

I infer that there is a deposit going on of maximum amount over the Old Rocks and those to the northward of the channel and decreasing as the entrance to the Sound is approached.

The amount in any given period of time would be difficult to ascertain but the character will be shown to some extent by an examination of the specimens of bottom. Whether the amount of matter deposited is sufficient in quantity to seriously affect the beds is a matter of conjecture. I should judge that it was not and my opinion coincides with that of all the oystermen I was able to interrogate.

That it must have some effect cannot be doubted and the evident deterioration of the beds in Pocomoke Sound may be accounted for, to some extent, by the supposition that the effect is injurious; but so many other and more direct causes exist for the deterioration that it is difficult to eliminate their influence. The fact that the beds have existed and have been worked since the first settlement of the country, would lead to an inference that the effect, if prejudicial, was very slightly so.

The scattered oysters lying on the sands and those beds in the vicinity of sand-shoals and in shallow water, the Muddy Marsh and Beach Island Rocks particularly, are exposed to damage by "sanding" in a manner similar to certain beds in Tangier Sound and which has already been described. The

large amount of grass, sponge and sea weed, growing on the sand shoals, especially the one to the east of Herne Island and south of the Guilford Channel, is frequently torn up by the heavy gales and deposited on the beds with the same injurious effect that it had in Tangier Sound. Heavy southerly gales will sometime cover the beds above the Buoy Spit and Shell Rocks with mud for a short time but not sufficiently long, it is said, to affect the oysters seriously.

EFFECT OF ICE AND GALES.

The heavy gales that occur in winter and summer, though principally during the former season, increase or diminish the depth of water on the beds sometimes as much as three feet. Strong northerly and northwesterly gales have the effect of diminishing the depth of water by piling up any floating ice upon the leeward shores and cutting away parts of the shores. Heavy southeasterly and southerly gales will increase the depth of water on the beds, stir up the soft muddy bottom of the channels and beds above Shell Rock and during the winter, in addition to piling the ice on the leeward shores and planted beds near Ape's Hole Creek, will pile it up on the Old Rocks, Buoy Rock and Shell Rocks. Generally speaking, the beds in this, as in Tangier Sound, are in too much water to permit their being uncovered by even the heaviest gales, or to allow the ice to ground upon them at any time; but those beds in shoal water, of about one fathom and the planted beds, which are generally in less, are subjected to both. The effect of gales and ice in Pocomoke Sound seems to be less than that in Tangier Sound, in consequence of its less extent and small area.

GENERAL INFORMATION GIVEN BY OYSTERMEN.

The following information is that derived from the answers to the questions propounded to oystermen. All the oystermen and dealers that were encountered during the season, so far as was possible, were interrogated. That which was not

pertinent to the subject or evidently influenced by self-interest or other considerations, has been excluded.

There has been no material change of the channel within the memory of the oldest fishermen, nor have they ever found oysters in the deep water of the main channels of either Sound. With regard to the improvement or deterioration of the beds, it was the general opinion that the beds had been much extended in size, that the quality of the oysters had improved, both as to size and flavor, but that the number on the beds had been very materially diminished, so much so, that it was hardly profitable to work on some of the beds. About thirty years back, the large beds in the Sound were not known to the fishermen and when first discovered and worked, the oysters were in clusters, long and thin valved and of poor quality, though very numerous and easily taken. Since their discovery and especially during the last ten years, the beds have been greatly overworked and the number of oysters much lessened.

Formerly, the best oysters were found on the Terrapin Sands, and there were none on the sands in shore of the beds; now the finest oysters in the Sounds are found on the sands bordering on the beds and are considered better than any in the general market. All the beds have been much extended by dredging, especially the Bird Rock in Pocomoke Sound and the Great Rock in Tangier Sound, the former being two-thirds larger than when first discovered, and the three rocks, of which Great Rock was originally composed, having been dragged into one continuous bed. Though thus extended, it was the opinion that there were not as many oysters on the beds at present as were found on the smaller areas. Fishing Bay, at the northern extreme of Tangier Sound, though the beds as a whole had deteriorated, during the last four years there had been some improvement on account of a more rigid observance of "close time."

The cause assigned for the deterioration, and even the admittance of the fact, depended very much upon the occupation of the informant. The tongers, or those who pursued the fishery with tongs alone, were unanimous in

laying the deterioration to excessive dredging, while the dredgers, or those owning pungies or other vessels employed exclusively with the dredge, while they admitted the decrease in the number of oysters, laid such decrease to the action of natural and unexplained causes, arguing that the evident extension of the beds and improvement of the oysters, due to dredging, was sufficient to prove its good rather than ill effects.

In regard to the effects of ice in cold weather, every one coincided in the opinion that the oysters in deep water were most affected, and those in shoal or brackish water were least so. In the same depths and character of water, those oysters about the edges of "muddy rocks" and close to muddy channels or sloughs were most affected by the cold or a severe freeze. After the latter event the packers distinguish the deep water oyster by its dark, slimy appearance, and decline it, though at the same time shoal water oysters are in good order and are accepted. With regard to the quality of the animals, those in the Sounds were considered finer than those in the creeks and rivers, and of the different beds those from the Shark's Fin, Terrapin Sands and Bird Rocks were considered superior. Regarding flavor alone, those from the salt water were the best, and generally the salter the water the better the flavor.

In regard to an increased freshness of water, due to freshets and heavy rains, it was the general opinion that during the winter season it was not of much consequence, but that in spring or summer heavy rains or freshets were very beneficial, especially in the spawning season, hastening its advent and shortening its duration. An increased freshness of water always fattened the oyster. Oysters in salt water were always poor and oysters were generally poorer after a dry season. Planted oysters above Pig Point and the Old Rocks, in Pocomoke Sound, have been known to die from absorbing too much fresh water and those on the Old Rocks have sometimes suffered from the same cause, but this only occurs during heavy freshets.

With regard to the depth of water and character of bottom, shallow water was preferred, and sticky mud or mud and sand,

about six inches in thickness over a hard substratum, was considered the best, though a larger amount of mud did not matter, provided it was not so soft as to allow the oysters to sink in it and had a strong current over it.

The oysters were said to feed on the flood tide, having their bills open then and at no other time. No one had noticed any enemies or animals that preyed upon the oysters, and all seemed to be ignorant of the drills and their destructive effects.

The oysters are "culled," that is they are separated from the old shells and other *debris* while the boat or vessel is on or near the bed. Everything except the oysters is thrown back, sometimes striking the bed and as often the mud. The young oysters under a year and a half in growth and less than two inches long are also thrown back.

All persons interrogated were of the opinion that at least seventy-five (75) per cent. of the oysters on a bed are taken off each year and that no more than fifty (50) per cent. should be removed. Off the beds near Haine's Point, at least one hundred thousand (100,000) bushels, or about 20,000,000 oysters, were taken in the season of 1878. Off the Great Rock, about 100,000 bushels, or 15,000,000 of oysters, were taken by one hundred boats in October and November of 1877. The oysters on the rock at the end of November were so scarce that but a very small number of boats could find profitable work on the bed. In the spring about 75,000 bushels more were taken up and sent North, and as the oysters were small, they amounted to probably 15,000,000 at least. Exclusive then of the fishing done during the winter months, in one season it is estimated that 30,000,000 of oysters were removed from one bed alone.

Nearly all the oystermen advocated a "close time," either from April 1st or May 1st to October 1st; many considered a prolongation until November 1st, and an entire rest every other year, would be beneficial.

With regard to transplanting the oyster and its transportation all experienced persons were of the opinion that delicacy of handling, and freedom from jars, concussions, and shocks

of any kind, was desirable. Oysters, when under hatches, have very frequently been killed by heavy thunder storms and firing of guns. Any concussion or sudden shock will prove destructive, if the animals are in a confined space. Oysters taken up during the summer are much more susceptible to injury from this cause than those obtained during the winter. Oysters are transplanted at any and all seasons but generally in the spring and autumn. Oysters obtained by the use of the "tongs" are preferred to those dredged, and generally those taken either before or after the spawning season are most desirable. The dredged oysters are apt to be broken about the bills, and will die on the planting grounds sooner and in larger numbers than the "tonged" ones. Those oysters planted about the Sounds are generally obtained from "tongers," but those sent to the North, being in such large numbers, are usually dredged. The size and age of the oysters to be transplanted depends on whether they are for early consumption or not. If the former, the larger and older the better, but in the latter case young oysters, from one to two years old, are preferred.

Generally any and all oysters are taken, without regard to age or size. The oysters for the Northern planting grounds are usually taken up as soon as ice clears away and are used during the spring. Those transplanted in the Sound are taken up later in the spring, or during the early summer or autumn months, and used during the following winter. Blunt-nosed oysters, with thick shells, do not thrive on the planting grounds. A change of bottom in transplanting oysters is not considered of so much importance as a change of water. The planted beds should be laid at the mouths of creeks and rivers having a rapid current. The bottom best for natural beds was considered best for planted ones.

The spawning season was said to be from May until August, inclusive, though most of the spawning was done in June and July. All opinions coincided that the oyster in shoal water spawned first, but differed as to whether the depth being the same, all oysters on the same bed spawned at or about the same time, as many being for as against the

theory. Currents were said to have no effect upon the spawning. Oysters of one year's growth, three-fourths of an inch long, have been seen with the spawn in them, and oysters on natural beds were thought by the majority to spawn sooner than the planted ones, though there was not much difference. Oysters transplanted with the spawn in them, however, will cease spawning.

A wet or warm spring would hasten the time of spawning, but would not shorten its duration. Heavy freshets were very destructive to the "spat" in Pocomoke Sound, driving it out into the Bay, and large schools of fish, especially trout and taylors, devoured a good many every spring and summer. The young were supposed to "strike" every three years, though there was but little regularity about it, a bed sometimes running for ten years with a young growth on it every year and then failing to produce anything for two or three years. Sometimes one part of the bed will be covered by young, and another part totally barren.

No systematic attempt had ever been made to increase the amount of "cultch" in the Sounds, though a few persons had placed old shells, ballast, boards and boughs about their planting ground and succeeded in making a good catch.

It was the general opinion that the oyster increased in size from one to two inches in the first year of growth and a little more than that during the second; afterwards the increase was much less. Oysters from two to four years old were considered as best for the market and are then from three to four inches long. Ten bushels of oysters were considered a profitable day's work for a tonger. For a dredger the number of bushels varied on account of their different sizes. About sixty bushels were considered a profitable day's work for the larger vessels and from twenty to thirty for smaller craft.

The dredging vessels employ from four to nine men and the "tonging" canoes one man and a boy. Tonging could not be carried on profitably in depths greater than four fathoms in the Sound and dredging in not more than six. The dredges vary in size, from two feet to four feet across the mouth

with from eight to sixteen teeth. Generally they are made about three feet wide, with twelve or fourteen teeth, but vary a good deal in weight. My informants found that generally speaking it was more profitable to fish with the tongs exclusively for the large oysters used for barreling by the dealers and to dredge for packing and canning establishments. The tongs are worked at small expense and the "barrel" oysters bring a much larger price, though they are necessarily selected oysters and more difficult to obtain. The prices paid during the season of 1877–78 were about one dollar per barrel for "barrel" oysters and from five to forty cents for the ordinary oysters from the beds; the "snaps," or most inferior quality, bringing the lowest price and forty cents being paid only for "extra culled" oysters. About twenty cents per bushel would allow a small profit. The flavor is not generally taken into account, and the degree of fatness and the size settles the price. Salt water oysters sometimes command better prices when intended for a special market or to supply some unusual demand.

With the improved appliances in use, as at present, the general opinion was that about twenty or twenty-five years ago one-third more oysters could have been taken in the northern part of Tangier Sound than at present, from two to five times as many about Crisfield, and in Pocomoke Sound nearly seven times as many as at the present day; that without any of the modern contrivances it was possible for either tongers or dredgers to take many more in a day than at present. The general opinion of all persons in and about the Sound, with very few exceptions, was that the beds were being worked much beyond their capacity and the majority were in favor of extending the "close time" as a remedy for the deterioration. Many thought that a resting time of a year or more would be beneficial. All were in favor of enforcing the law prohibiting the dredging and working of the beds during the "close time," and all testified that there was no attempt toward the enforcement of the law at present, either by the oyster police or any one else.

CONCLUSIONS.

The foregoing pages with the record and charts, contain all the data collected during the season for the study of the beds and the conditions affecting the animals upon them. Not regarding it as within my province and not possessing sufficient knowledge of the subject, I have not attempted any study of the biology of the oysters but have confined my report to as concise a description as possible of the beds and conditions surrounding the various forms of life upon them. The following remarks are simply the conclusions drawn from certain peculiar features and facts established by the investigation and testimony and an attempt to account for them. In reviewing the remarks upon the different beds, it will be seen that there is a marked absence of oysters classed as "young," or those supposed to be of the last brood on all beds above Kedge's Straits in Tangier Sound, and above the Bird Rock in Pocomoke Sound. In Tangier, the young first appeared in considerable quantities on the middle of Muscle Hole Bed and Piney Island Bar. There were none in either the Manokin or Big Annemessex Rivers or on the northern part of Harris Rock, though large numbers were found on the central and southern portions of the latter. The southern beds of both Sounds were plentifully supplied. Again, on the southern beds there was a like absence of the class termed by us "young growth," or oysters apparently spawned during the previous season, while on the northern beds of both Sounds the proportion of this class was very large. Over these different beds the change of density is too slight to enter into the question and the currents too nearly similar, both in direction and strength, to have influenced the difference in production. On nearly all of the northern beds in both Sounds, the bottom is muddy or the beds in close proximity to muddy bottoms. To the southward, however, the bottom is hard and the beds surrounded by sand or gravel, except on the edges nearest the channels. Again, all the northern beds in both Sounds are in comparatively shoal water and those in the southern parts in deep water.

There are, then, two similar facts noticed in both Sounds with regard to the presence and absence of the young and "young growth;" the former have been found in deep water and on hard bottoms, the latter in shoal water, on or near soft bottoms. The character of the bottom can hardly be of much importance in this case, for though a hard clean bottom is necessary for a successful attachment of the "spat," yet the bottoms on the northern part of the Sounds must be sufficiently so to obtain a large quantity, as is shown by the large number of young growth on those beds and that the absence of the young is not due entirely to that cause is shown by their scarcity on the Chain Shoal and Drumming Shoal beds in Tangier and Shell and Muddy Marsh beds in Pocomoke Sound, where the bottom is hard and moderately clean. Remaining then as the only probable cause known to us is the difference of depth of water. It will be found upon reviewing the remarks and record, that almost invariably the young are found in deep water and the young growth in shoal. It was the opinion of the oystermen that the oysters in the Sounds increased from one to three inches in length in the first year of their existence. The class termed "young growth" by us were from three-fourths of an inch to one and a half inches long; and supposing the oystermen to be correct in their estimation of increase in size, the class termed "young growth" would then be of the same season's brood.*

The investigation of the beds was carried on in September, and in Tangier Sound; the principal amount of information was collected during the latter part of that month and the first part of October. If, then, the oysters on the shoal water beds had spawned in the early part of June, they would have had about four months growth when our observations were made. In searching for spawn in the oysters during the latter part of August and first part of September, Mr. Rice was unable to discover any except in those from deep water, and that fact, together with the inference drawn from the preceding paragraphs, leads me to believe the oystermen correct in stating

*Spawned much earlier than those termed "young."

that there is a difference in the time of spawning of the shoal and deep water oysters. There is but one other way of accounting for the absence of young on the northern beds, and that is by accepting the supposition that the "spatting" not only does not occur every year, but that it only occurs on parts of the Sounds during each season. Such is the opinion of many people of experience; but I am inclined, from the results already given, to prefer the other solution of the problem, not having found any reason that would support the opposite theory or lead to its entertainment.*

The difference in time of spawning in shoal and deep water is probably due to difference in temperature, the deeper water naturally being of the lowest. The establishment or the refutation of this supposition, as also of that of the difference of the times of spawning, is very necessary, especially of the latter, as it would afford a sure basis for such legislation for the protection of the beds as will soon be necessary. Aside from the general absence or presence of young on particular beds, it was noticed that a much smaller number were found on or adjacent to the muddy bottoms, or on the sands where there was much grass or sponge. On the beds a large number of young were seldom found where there was much of the red moss, though there was not always a diminution of the former when the latter was present.

The absence of the young may be very readily accounted for if the moss had formed previous to the "spatting," as it would prevent the exposure of the "cultch." The moss or weed is of very rapid growth, and I was informed that on an unworked bed it had been known to become three or four feet thick in a few months. If, then, it had formed and commenced growing after the "spatting" season, the young would not be as much disturbed by it as they would if the growth had been previous to their advent. This is another argument in favor of the theory that the depth of the water influences the time of spawning, as the effect of the moss or weed upon the numbers of young was greater in deep than in shallow water. The number of drills were, generally speaking, in direct pro-

*NOTE—Reference is made to this statement in Report of 1879.

portion to the number of young, and the Pocomoke beds, especially the Bird and Hern Island Rocks, appeared to have suffered most from their ravages.

A description and sketch of this animal, taken from specimens preserved by me, has been made by Mr. W. H. Dall, Assistant, who has kindly furnished me with copies. Very few star fish, and no other enemies were discovered in the Sounds, and the drills are probably the only ones that do any considerable damage.

In regard to the beneficial effect, or the reverse, of fresh water, there can be no doubt that the oysters at least appear fatter and are superior after absorbing it, though they become poorer in flavor.

In order to test the effect of fresh water upon them and to determine if the low spring tides had any share in causing the decrease in the numbers on the beds, a dozen oysters were selected from the same bed and haul of the dredge. Six of them were opened immediately and inspected and found to be rather poor, of small size, and dark color, but of the ordinary flavor. The remaining six oysters were placed in perfectly fresh water for twenty-four hours, the water being changed several times during that interval. They were then opened and inspected. They were alive and in good order, very fat, or apparently so, and of a creamy white color and much swollen, but of very insipid taste. As the oysters were alive at the end of a day's immersion in fresh water, they can not well be destroyed by the brackish water of low Spring ebbs, to which they would not be exposed for more than six hours, though a continuance of heavy freshets might very seriously affect them. As there is but one river in both Sounds (the Pocomoke) likely to subject the oysters to this evil, for the main beds there is nothing to fear.

The evil effects of sudden jars and concussions are probably due to the breakage of the delicate pedal muscle, which after the spawning season, in common with all other parts of the animal, is in a more or less weakened condition.

In explaining the fact that the oysters in deep water

are more affected by cold water and ice than those on the shoals, it is necessary to remember that the lower the temperature of sea water the greater its density, and thus as the surface water becomes cooler it would sink. The freezing point of salt water is below that of fresh. Therefore the oysters in the deep water, or generally speaking, those remote from the mouths of the streams, may have surrounding them water of a slightly lower temperature depending upon the amount of salinity than those oysters near the creeks and rivers that are surrounded by ice. Again, the deep water would be much slower to lose or acquire heat than that on the surface or in less depths, which would necessarily be affected quickly by all changes of weather.

The statement that the oysters recover and reappear after the "sanding" process, must be received with great caution, opposed as it is to most experience. That some few may survive is possibly the case, but that the majority recover after being covered with sand for any length of time is very doubtful.

The testimony of all persons in the neighborhood of the Sounds was to the effect that the beds were deteriorating. In the absence of any reliable observations, extending over any length of time, their opinions must be taken as correct, at least as to the fact, although perhaps only approximately so as to the degree. Accepting, then, the statement, it is necessary to account for the deterioration if possible.

After the original formation and growth of the beds they would at some time, the same conditions continuing, cease their development, neither increasing in size or in number of oysters, there being a natural limit to expansion in either direction. Supposing, then, a bed to have extended itself as far as the conditions of bottom and water or other natural limit would allow, all future expansion could be only in the number of oysters on the bed and this is limited principally by the amount of food and the room for development, the question of enemies not being considered, as there being no increase if they were not in sufficient numbers to prevent the growth of the bed and number of oysters, they would not be sufficient to cause its destruction or deterioration.

The number of oysters would then, on a limited bed, steadily increase, as long as there was sufficient room and food supplied them, until they had reached their limit, a rather indefinable one in that direction, the quality of the oysters not being taken into consideration. Having reached that point, the number of oysters would to all intents remain the same as long as the conditions under which they had previously lived were not changed. To cause, then, either an increase or diminution of the number of oysters or size of the bed, a new factor must be brought in, when, all conditions being changed, the life of the animals begins anew and progresses differently. As there can be no doubt that both the beds and oysters of Tangier and Pocomoke Sounds have changed greatly in character since their first discovery, in accounting for that change it is necessary to discover the new factor or factors that have been introduced, and that have been instrumental in effecting it. Briefly, the change in the beds has been a material expansion of their limits and a material diminution of the number of oysters upon them, and therefore the causes for such changes must be sought among such as it is known would produce like effects.

Disregarding for the present the agency of man in the matter, the question is what natural cause or causes would both expand the beds and diminish the number of oysters? A bed is extended naturally by the drifting spat or "young brood" attaching themselves to any clean, hard and moderately rough substance contiguous to the bed. The locomotive powers of the "spat" exist for but a short time and, except when assisted by the current, they can only move a short distance, and unless some suitable object soon presents itself for their attachment they will sink into the soft bottoms and die. The principal expansion of the beds so far as could be effected by nature must, however, have been accomplished long ago, the beds being surrounded originally, and indeed at present, by soft bottoms of a character which would be most destructive to the "brood," unless some substance was interposed between it and them for their reception. Natural expansion can only be achieved to any extent in the manner described, and though probably there is, and has been, a slow

extension of the beds due to natural unassisted causes, their great increase in area during the last thirty years must be assigned to other agents.

The diminution of the number of oysters may be affected by several natural causes. An increased deposit of earthy or vegetable matter upon the beds would, if in sufficient quantities to bury the oyster, effect the destruction of both old and young. No such deposit has been noticed, nor could it well occur without showing its presence in other ways, principally by changing the channels and causing shoals; but no such changes have occurred, my investigation showing but slight deviations in either channels, shoals or character of the bottom from that established by the first hydrographic survey of the locality. A change in the character of the water and bottom, which would probably follow a change of channel, and might occur without such change, might, by depriving the animals of their proper food, cause their deterioration and destruction. But such a change, though it would certainly diminish the numbers on the beds, would do so suddenly and the evil effects would be noticed in the oysters remaining, their quality and flavor, indeed, their vitality, being very much impaired. No such impairment has been observed, however, the oysters being larger and finer than when the beds were first discovered. That fact alone will eliminate many quantities from the equation, for any natural cause injurious to all the oysters on the beds would be evident at once by an examination of those found at present. If, however, the destruction or non-production of the necessary number of young is accomplished by means that are not harmful to the mature oyster, a cause is discovered for the diminution of all in harmony with the existing facts. Considering first the destruction of young; large numbers, immense when compared with the ordinary production of other animals, are without doubt naturally destroyed by the falling of the "spat" upon unfavorable grounds, the prevalence of heavy freshets which would drive the "brood" into the Bay, and probably cause its loss, and the ravages of various enemies. But all these causes have been in operation continually since the first formation of the beds, and the animals have survived

and increased while contending with them. Therefore an increase of power for injury must be assigned to one or all of these to account for the diminished number of oysters. Probably the "spat" falls on more favorable ground since the beds were discovered than was formerly the case, owing to the increased amount of "cultch" due to the fishing of the beds, and aside from that, the conditions surrounding and operating upon the beds are so similar to those in the past that the loss of the young could not be much greater from the want of attachment.

The freshets and other natural causes for diminished numbers of young have also been long in operation, and the deterioration cannot be justly assigned to them. Remaining then to be accounted for are the ravages of enemies. Those found by us during the season were drills in large numbers and a very few star fish, but as the oystermen were ignorant of both their presence and destructive effects, I am unable to decide whether they have increased or diminished in numbers. There is no doubt that very large numbers of young are destroyed by the drills; fully fifty per cent. on some beds in Pocomoke Sound. If, then, these small enemies have only within late years entered the Sounds, we have one of the principal causes for the deterioration of the beds. But as there is also a marked deterioration upon those beds upon which no drills were found, still another cause must be at work and must be sought in the non-production of the young. This is caused by the failure of the "brood" oysters, they having been removed or become extinct, thus causing a failure of impregnation. If the theory is correct that there is a mutual fecundation partaken of by all oysters on the beds, the spermatozoa being formed and milted somewhat prior to the formation of ova, then it can easily be understood that if the oysters are so much separated that even the tides and currents cannot bring the spermatozoa within reach of the adjacent animals, there could be no production of young. Taking for instance the most exaggerated case in both Sounds, that of the Muddy Marsh bed, it will be seen that the set of the current over it is not generally from any other adjacent bed,

the nearest one being Parker's Rock, which is over three miles distant; the oysters on the Muddy Marsh bed were very few and the mass of shells immense, affording ample surface for the attachment of the drifting "spat," should there be any. But supposing the oysters on the beds to have been so much diminished that they were not sufficient for mutual fecundation, the distance and situation of other beds is such as to prevent the current from bringing the spermatozoa voided upon them to the Muddy Marsh Rocks and there would be, as was noticed, an almost entire failure of young. In the same, though less degree, would the other beds suffer, the amount of spawn voided depending not only upon the number of mature "brood" oysters, but upon their distance from each other and the spaces separating the beds. This theory is supported by the investigations that have been made in England, France and Prussia, and almost all opinions coincide that the number of young in any spatting season is dependent upon the number of "brood" oysters upon the beds. Indeed, it seems so self-evident a proposition that it is hardly worth while to experimentally establish it. It is necessary, then, having accepted the theory, to determine what proportion of the oysters should be taken off the beds, and what proportion is actually removed. As there is no data to my knowledge derived from observations made in this country to determine the first of these two desired points, it is necessary to turn to the experience of foreign oyster fisheries for guidance, and though the animals and the conditions under which they live are not entirely similar, yet some information may be obtained and a line of investigation marked out for the future.

The following is a synopsis of the deductions of Professor Karl Möbius, Professor of Zoology in the University of Kiel, whose work on the oyster in manuscript was kindly lent me by Professor Baird. The observations were made over the Schleswig Holstein oyster beds by government officials from 1730 to 1852, and were carried on in practically the following manner. Each bed was dredged over in three or six places, according to its size, and the oysters taken were divided into three classes, and carefully counted. The classes were denom-

inated "marketable," "medium" and "young growth." The "marketable" oysters were full grown and mature, from seven to nine centimeters in length and breadth, and eighteen millimeters thick. The "medium" were half grown oysters, from sixteen to eighteen millimeters thick, and of less than nine centimeters in breadth. The "young growth" were those one or two years old. From these observations Prof. Möbius discovers that there was an average of 421 medium oysters to one thousand full grown ones; that is, out of every 1421 oysters there would be only one thousand full grown ones. (?) The average of all observations differ very little from the number given by each, and consequently shows that there was but slight fluctuation in the proportion in 122 years. The medium oysters are considered by Prof. Möbius to be those descendants of the marketable ones that have survived their most precarious years of existence, and escaped their principal enemies, and are consequently likely to reach their full growth. They thus represent the total number of embryos spawned which have survived in the struggle for existence. From his (Möbius') experiments, he decides that an oyster spawns about one million embryos in a season, and that forty-four per cent. of the mature oysters give forth "spat." [Other authorities are of the opinion that only about ten per cent. spawn; Prof. Möbius' data appears hardly sufficient to justify his conclusion.]

From the above it is evident that in an assemblage of a thousand oysters, 440,000,000 embryos can be voided every season, and of them 421 would survive, or 1,045,000 embryos would be destroyed where one was preserved. But the medium sized oysters also spawn, though they send forth a much smaller number of embryos. Möbius estimates that the 421 in the community would produce about 60,000,000 of "spat." It would therefore require about 500,000,000 embryos to produce 421 medium oysters, or 1,185,000 to produce one. From the above it is evident that it would be necessary to have 4.2 oysters assembled to produce one, though the proportion would only hold where there are much larger assemblages. Regarding these results, Prof. Möbius is of the opinion that no more

than 40 per cent. should be removed each year, but, in my opinion, in order to maintain the oysters at a constant number in the above case, no more than 25 per cent. should be taken, as the one oyster in four would be replaced each year. No comparison between the Schleswig-Holstein beds and those on our coast can well be instituted, as the beds in the Tangier and Pocomoke Sounds are of greater extent, and as the more extensive the bed the greater the breeding power, I should consider that until the annual number of mature oysters produced is known, it would be safer to take about 50 per cent. from the beds, supposing them to be in good condition. That is but an estimate, and may be an erroneous one, but certainly it is not too small, and it now remains to be seen what number of oysters are actually removed from the beds. I regret that statistics of the oyster trades in the Sounds are not at hand for reference, and also that the pressure of other work while I was in that locality prevented me from obtaining them. Such observations as I was able to make, however, will furnish a basis for a somewhat rude estimate of the number of oysters and young taken off the beds during the season. While in Crisfield harbor, about the 11th October, there were counted fifty-seven sail oyster dredges, and the number of bushels carried by them estimated, and the estimate verified by the subsequent statements of the masters of the several vessels in each class. The following table shows the result:

TABLE I.

Class.	Number.	No. of Bushels.	Average No. of Bushels.	Class of Vessel.	Number.	No. of Bushels.	Average to sail.
Schooners.	37	2075	56	Buckeyes	4	45	11
Sloops	12	256	21	Canoes	4	32	8
Total		2331		Total		77	
		77					
Grand Total		2408					

The day had been a bad one for dredging, and but a small number of dredgers had been at work, and they had come into port much earlier than usual, consequently the average and total number of oysters are below the usual figures. On the same day, in order to ascertain the number of young attached to the mature oysters that were taken off the beds, I had three samples, of a peck each, selected from different vessels entering the harbor, and the number of young on the shells counted. The vessels were of different sizes and from different localities. The results are shown in the table following:

TABLE II.

Vessel.	No. Bushels.	No of Young to the Peck.			Bushel Average.	Localities from which obtained.
		1st.	2d.	3d.		
Sloop......	13	13	.....	.....	72	
Schooner ..	30	93	125	163	508	The small proportion from Great Rock, the large from Terrapin Sands.
Buckeye	15	33	.....	.....	132	Deep Water Rock, Kedge's Sts.
Sloop	23	73	88	.....	322	Paul's Rock.
Schooner....	90	76	78	.....	308	Great Rock.
Schooner....	65	32	67	.....	192	
Schooner....	80	55–	89–	57–40	221	Great Rock and Thoroughfare.
Buckeye....	10	1	.....	.....	4	Paul's Rock (Sands).
Buckeye....	25	49	.....	.....	196	Great Rock (northern part).
Schooner....	50	64	39	23	168	Great Rock.
Schooner....	150	67	35	.....	205	California Rock.
Total					2228	Average 202 per bushel.

The total number of bushels brought into Crisfield, as seen by table number one, amounted in one day to 2408, and estimating the number of oysters to a bushel to be between 150 or 200, we have for the results of one day's fishing from 361,200 to 481,600 oysters, and about 486,000 young. During the progress of the work in the Sounds, there were twenty-four counts made of the dredgers in sight from the vessel. In order that some idea may be formed of the number of oysters taken by these dredgers, an estimate has been made, based

upon table number two, of the number of bushels and young carried off the beds. In forming the estimate, all the vessels in the Sound were divided into three classes. The first being an assemblage of all the different craft, the second only the smaller classes, and the third, where about two-thirds were small, and the remainder large craft. The number of sail counted were then placed in one of these classes, we having observed when among the dredgers the particular class and size of vessel usually working over a particular ground. In order to ascertain the number of bushels to each vessel, the total number of bushels brought in [2408] was divided by the number of sails [57], which would give forty-two bushels as the average to a sail. A closer estimate is obtained from table No. 2, where the number of bushels assigned to each craft is that given by their master. The total number of bushels [551], divided by the number of sail [12], gives forty-five and a fraction as the number of bushels to each sail. I have divided by twelve instead of eleven, because the last number in table No. 2 was the result of two days' dredging.

The average number of bushels per sail for the second class, by table No. 1, is 16.6 bushels; by table No. 2, 17 bushels. The average for the third class is by table No. 1, 29 bushels; by table No. 2, 33 bushels. In all cases the smaller numbers have been used in calculating the number of bushels of oysters. The total number of bushels taken from the beds in both Sounds in thirteen days was 47,842, and allowing from 150 to 200 oysters to a bushel (though the number is probably larger), there would be removed from the Sounds in the very first of the season from 7,176,300 to 9,568,400 oysters. This, however, is far below the real number, as the entire area and number of sail were not visible at the same time.

In order to estimate the number of oysters removed from the beds in each day, I have divided the Sounds into four sections. The first section comprises all of Tangier Sound north of Little Island and the Muscle Hole Bed. The second section comprises all of that part of the Sound, including Manokin and Big Annemessex rivers, between Little Island and Jane's Island. The third section comprises all of

Tangier Sound south of Jane's Island. The fourth section all of Pocomoke Sound.

Assembling the number of dredgers known to have been dredging on these different sections, and the number of bushels taken by them, I have deduced the following results:

Locality.	1st Section Upper Tangier.	2d Section Middle Tangier.	3d Section Lower Tangier.	4th Section Pocomoke.
Total No. bushels taken............	15,135	10,115	18,060	* 2,673
(in)				
No. of days......................	4	4	6	3
Average per day..................	3,783	2.523	3,060	891
Average No. Oysters per day.......	567,450	378,450	459,000	133,650
Grand Total taken off in one day..........				1,538,550

* 150 oysters are given to the bushel.

Though there were dredgers in large numbers at work early in September, and also many during the entire summer, yet in order that any error may be under, rather than over estimation, I will consider the working season to be from the first of October to the first of May, and allow three days in each week for bad weather which would prevent dredging. That allowance will leave 120 working days, and in that time, by the preceding table, over 184,600,000 oysters would be removed from the beds in the Sounds, supposing them to supply the same number during the entire season. By table No. 2 it will be seen that the average number of young to a bushel was 202. That number represents the number of young oysters attached to the shells of the full grown ones that were removed from the beds. That the estimate is not above what is actually the case I am certain from the immense numbers of young brought up by our own dredging operations. In making up the estimate twenty and thirty young were frequently found on one shell, and in one case fifty-four were counted. In estimating the total number removed from the beds in one day,

only those vessels dredging on such beds as were known to have a large proportion of young upon them have been considered, and even then the estimate reaches the astonishing figure of 1,238,790. These oysters are those of from two to five months growth, and may be said to have survived the most precarious portion of their existence, their shells having become hard enough to resist the drills to a certain extent, and they being firmly attached to the mature oyster, and in no danger of destruction from any cause to which it would not be equally exposed. Still many of them would doubtless perish even if undisturbed, for though all oysters on the beds mature, or others, would suffer if exposed to unfavorable conditions, yet many of those conditions would affect the young and young growth to a greater degree than the mature and more hardy oysters. I will, therefore, suppose that fifty per cent. of the young taken up would never have reached maturity, and will also make another and very liberal supposition that by the first of April the young would have reached such a size as would make it profitable to open them. That would make the working season, so far as the young were concerned, 104 days, and the number of young removed would amount in that time to 128,834,000, of which about 64,417,000 would probably have attained their full growth.

These young are a total sacrifice, never seeing the water again after their removal and generally perishing on distant or adjacent shell heaps. Many more are probably destroyed by carelessness in disposing of the old shells brought up by the dredge. The dredging is usually across the bed, and the shoal hard ridges noticed along the edges of the beds on the western side of Tangier Sound and on all edges adjacent to muddy bottoms, are, no doubt, caused by the dredgers who, as they approach the edge of the bed, having dragged across it, haul in their dredges just before getting over the muddy bottoms. They then stand on tack or "wear" and as soon as on the bed drop the dredges again.

In the meantime the crews have been busily "culling" the oysters, and, as likely as not, have thrown over on the soft mud a far larger number of young attached to the shells than

they have taken off on the oysters. No account has been taken of the number of mature or young oysters removed by the tongers, and the estimates are based upon observations made at the commencement of the fishing season, when the prices being low, a smaller number of dredgers would be at work; therefore, there is every reason to believe that the estimate of both classes of oysters is under, rather than above, the real number removed. We have then, aside from the ravages of the drills, a yearly destruction of over 64,000,000 young, and the removal of 184,600,000 mature spawning oysters to account for the deterioration of the beds. Whether this extensive fishing is beyond the capacity of the beds or not cannot be accurately stated; the only information on the subject obtainable being the statements of the oyster-men, that the beds are deteriorating from that cause. But an estimation of the effect of excessive fishing may be formed by examining its results upon such beds in England and France as have records upon the subject. The most instructive of these are the records of the production of the beds of Cancale Bay, on the northwest coast of France, which extend over a period of sixty-eight years—from 1800 to 1868. The beds in the Bay comprise an area of about 150 acres, and from 1800 to 1816 produced from 400,000 to 2,400,000 a year. This, however, was the period of the Napoleonic wars, and the fishing was much disturbed by the presence of the English cruisers. During this time the beds became so thickly stocked that the oysters were in some places a yard thick. After the close of the war the fishing improved and the oysters were removed in larger and increasing numbers until 1843. From 1823 to 1848 it is supposed that the dredgers were living upon the oysters accumulated during the period of enforced rest, from 1800 to 1816. In 1817 the number of oysters produced was 5,600,000, and until 1843 there was a constant increase, the number taken in the latter year being 70,000,000. In 1848 it was 60,000,000; thenceforward there was a constant decrease. From 1850 to 1856 the decrease was from 50,000,000 to 18,000,000, supposed to be the effect of over-dredging. From 1859 to 1868 the decrease was from 16,000,000 to 1,079,-

000; the oysters having almost entirely disappeared from the beds, though on account of the suffering condition of the inhabitants of the shores it was almost impossible to prevent it. In 1870 there was a complete wreck of the bottom, which could only be remedied by a total prohibition of the fisheries for several years. From the beds of the districts of Rochefort, Marennes and island of Olévon, on the west coast of France, there were taken in 1853 and 1854 10,000,000 oysters, and in 1854–5 15,000,000.

On account of exhaustive fishing in 1863–4 only 400,000 could be obtained. According to the testimony of Mr. Webber, Mayor of Falmouth, England, about 700 men, working 300 boats, were employed in a profitable oyster fishery in the neighborhood of Falmouth until 1866, when the old laws enforcing a "close time" were repealed, under an impression that owing to the great productive powers of the oyster it would be impossible to remove a sufficient number to prevent the restocking of the beds. Since 1866 the beds have become so impoverished from excessive and continual fishing that in 1876 only 40 men and 40 boats could find employment, and small as the number is, they could not take more than 60 or 100 oysters a day, while formally, in the same time, a boat could take from 10,000 to 12,000. According to the statement of Mr. Messum, an oyster dealer, and secretary of an oyster company at Emsworth, England, made before the Commission for the Investigation of Oyster Fisheries in May, 1876, there were in the harbor of Emsworth, between the years of 1840 and 1850, so many oysters that one man in five hours could take from 24,000 to 32,000. In consequence of overfishing in 1858, scarcely ten vessels could find loads, and in 1868 a dredger in five hours could not find more than *twenty oysters*. The oyster fisheries of Jersey, in the English Channel, afforded employment to 400 vessels. In six or seven years the dredging became so extensive and the beds so exhausted that only three or four vessels could find employment, and the crews of even that small number had to do additional work on shore in order to support themselves.

The foregoing are a few of, though by no means all, the in-

stances that may be quoted in order to show the disastrous effects of over-working the beds, and in concluding the remarks under that head, it will be instructive to extract from Professor Möbius' work his prophecy with regard to our own beds, which is here introduced:

"In North America the oysters are so fine and so cheap "that they are eaten daily by all classes. Hence, they are "now, and have been for a long time, a real means of subsist- "ance for the people. This enviable fact is no argument "against the injuriousness of a continuous and severe fishing "of the beds. * * * * But as the number of consumers "increases in America the price will also surely advance, and "then there will arise a desire to fish the banks more severely "than hitherto, and if they do not accept in time the unfor- "tunate experience of the oyster culturists of Europe they "will surely find their oyster beds impoverished for having "defied the bioconotic laws."

The question now to be decided is how the protection of the beds and their improvement is to be brought about. The protecting laws of the State of Maryland, which govern the larger part of the Sounds, are briefly as follows: Dredging is allowed from October 1st to May 1st. Taking of oysters in other ways from September 1st to May 1st. Dredging is not allowed in the rivers and creeks of the Sounds or in their mouths. No steam dredgers are allowed. All dredgers and "tongers" must be licensed. Violations of the law are punished by not more than two years imprisonment nor $200 fine. For the enforcement of these regulations there is established a State Fishery Force, consisting of one steamer and several small sloops; one of the latter having jurisdiction over Tangier and Pocomoke Sounds. The officers of this Fishery Force and the sheriffs and constables of the different counties are empowered to make arrests and enforce the law.

The above is the amount of protection afforded by the law if carried out. In the Sounds, in reality, there is none. Neither the State Fishery Force, sheriffs, constables, or any other persons make arrests or enforce the law; the public opinion of the community being against such a proceeding, though every

one recognized the necessity when considered in the abstract. I have seen numbers of dredgers at work and the police boat cruising among them, and this was during the latter part of August, when, if at any time, the oysters should have been free from disturbance. Before deciding upon the measure of protection to be given to the beds, it may be well again to see what has been accorded by foreign governments, and with what success. On the Schleswig-Holstein banks the "close time" is from the 9th of May to the 1st of October; no oysters less than two and a half inches in length are removed at any time. The law is enforced, and still the beds are deteriorating. In Ireland the "close time" is from May 1st to September 1st, and in some localities of the coast from the 1st of April and the 1st of March until the 1st of October and the 1st November. It is unlawful to dredge or have in possession any oysters or oyster brood during the "close time."

The Inspector of Fisheries can call a meeting of interested persons to decide upon a change of "close time." Inspectors are empowered to permit the planting of oysters and to prohibit the presence of dredgers on board any boat during the close time. The coast guard and constabulary are empowered to enforce the laws, and violators are suitably punished. The deep sea fisheries for oysters in the English Channel are governed by rules adopted by England and France. The close time is from the 16th of June to the 31st of August. Any boat having a dredge or other implement used for taking oysters during that time is considered as having violated the law. Competent courts of each country have power to punish offenders, and the cruisers of each nation power to enforce the law, which is strictly observed by the French fishermen and frequently violated by the English. In France the oyster beds are protected by stringent and effective laws, which may be briefly stated as follows: The government assumes control over all oyster banks and foreshores. As occasion may seem to require, an entire bank or part of it may be reserved from dredging for a certain time, decided by the local commission. The general practice seems to be to buoy off a third or fourth of a bank each year, which

portion is only sufficiently dredged to remove weeds, mud, vermin, &c. The remainder of the bed is opened to all licensed persons for a certain specified time. The following year another part of the bank is reserved, and occasionally parts are reserved for a longer period. The local commission decides all matters pertaining to the beds and their vicinity, and is composed of the following officers: The Inspector of the Fisheries, the Commander of the Fishery Guard, two "Gardes-Maritimes, one fisherman, master of a boat. The following are the most important regulations made for the guidance of the Commissions by the Minister of the Marine: The beds should not be opened for fishing until the spat has acquired strength to resist the action of the dredge; until the end of January, for example. When a bed has well established breeding capacities a fourth or fifth part of its total area should be set apart as a reserve, and dredging over such part entirely prohibited. A Fishery Guard boat should, whenever practicable, take part in the working of each bed. When a bed is foul or encumbered with weeds or other matter noxious to the development or adherence of spat, it should be open for dredging until cleaned. Beds on which there is never any production of spat shall be opened all through the season. After the working of any bed is over, it should be carefully inspected, and if necessary, the cultch replenished. The close time is between the 1st of May and the 31st of August, and is strictly observed. The foregoing regulations have caused a great improvement in the beds on the French coast, and the regulations of other nations have been made and enforced in time to prevent the depletion of their beds.

As an instance of the effect of this protective policy, when understandingly conceived and rigidly enforced, the beds in the Bay of Arcachon are a good example. In 1870, through over-fishing, they had become entirely exhausted, but by the strict protection afforded them their fecundity has once more become so great (in 1876) that the waters of the Bay from June until August are filled with the young swarm. On a bed when dry, at low spring ebbs, comprising 26.7 acres, there were taken by 40 or 50 persons, in about two and a half

hours, 60,000 oysters. That part of the bed was immediately buoyed, and no more fishing allowed during the season.

Having then seen what is considered necessary for the protection of the beds by European nations, and why it is necessary, the question is how we can best use their experience. The best remedy for any evil is the removal of the cause, and the beds in Tangier and Pocomoke Sounds are suffering from over-dredging and the destruction of the young brood. Until the rate of production and the proportion between the number spawned and the number reaching maturity is decided, only a specified number should be taken off of each bed in the Sounds. If observations, both as to the number removed and the increase or decrease of the proportion to the square yard were continued, a basis might be found for the establishment of the maximum number to be removed. Until that number is established no working of the beds should be permitted between the middle of April and the first of November, and none of the beds in Pocomoke Sound should be dredged over at all, except so much as it is necessary to clean them. There should be a sufficient number of oyster guard-boats to superintend the dredging, both in general and when for cleansing purposes; to collect statistics as to the number of young and mature oysters removed, and to make all observations as to the proportion to the square yard. They might also collect a good deal of useful information while on the beds. During September and October they should examine the beds, in order to ascertain the number of young, and those beds having a large proportion should be reserved from dredging operations until the young are able to resist the action of the dredge. No oysters below a certain size should be taken off the beds, and it should be punishable to have those under the specified size in possession. Whenever it is judged that any bed open to general fishing is being worked beyond its capacity, the oyster guard should have power to prevent any further dredging on it. When any bed with a large number of young upon it is open, either the packers or fishermen should be compelled, as far as possible, to return the shells to the beds, or the hard bottoms surrounding them, within a cer-

tain specified time, provided that the oysters were opened in their immediate vicinity. Large numbers of young would thus be saved and the areas of the beds increased. No one should be allowed to take or to possess an oyster having more than a specified number of young attached to it. During the time when not otherwise employed the oyster guard-boats could be usefully engaged in removing the weeds and grass from the sand shoals, and the moss from the closed beds. It must be remembered that dredging is not an unmixed evil, and that the improvement of the oysters and the extended areas of the beds are mainly due to it; but it should be conducted under suitable restrictions, and in this connection may be advised the use of the scrape where it is now prohibited, and the prohibition of the heavy dredges in shoal water and on the soft bottoms.

If there is any animal known to naturalists that is an enemy of the drill and not harmful to the oyster, its introduction into the Sounds would be a great benefit, and finally, if in the spring either the State or the fishermen would collect the shells from the piles about the packing houses and deposit them on the hard bottoms contiguous to the beds, they would furnish an excellent "cultch" for the "spat," and probably make a good catch and a permanent extension of the oyster ground.

I have made the above suggestions with the hope that they may in some way bear fruit for the benefit of those engaged in the oyster fishery in the Sounds and Bay. Some more adequate protection than that now offered must soon be afforded or loss and distress among the large number of people in Maryland and Virginia engaged in the fishery will soon follow from the failure (and that more or less sudden) of the oyster industry. In concluding this part of my report, I cannot do better than to again quote Prof. Möbius, whose remarks on the preservation of natural banks of oysters are well worthy of attention:

"In conclusion, I hereby give as the foundation for all "oyster culture the most important rules for the improvement "of the natural oyster banks.

“ First. An oyster bank will yield permanently the greatest “ profit if it possesses such a stock of full grown oysters as “ will be sufficient to maintain the fecundity of the bank in “ accordance with its bioconotic conditions.

“ Secondly. When the natural conditions will admit of it, “ the yielding capacity of an oyster bed may be increased by “ improving and enlarging the ground for the reception of the “ young brood. The natural banks should be improved by “ removing the weeds and plants with dredges and properly “ constructed harrows, and by scattering the shells of oysters “ and other mussels over the bottom. When circumstances “ will permit, all the animals which are taken in the dredge, “ and which kill the oysters or use up their food, should be “ destroyed. It would be much more judicious and much “ better for those who eat oysters if the ‘close time’ could be “ extended until the 15th of September or the 1st of October, “ so as to allow the oysters some time after the expulsion of “ the contents of the generative organs to become fat before “ being brought to the table. If it is desired that the oyster “ banks should remain of general advantage to the public and “ a permanent source of profit to the inhabitants of the coast, “ the number of oysters taken from the beds yearly must not “ depend upon the demands of the consumers or be governed “ by high price, but must be regulated solely and entirely “ by the amount of increase upon the beds. The preservation “ of the oyster beds is as much a question of statesmanship as “ the preservation of forests.”

AREAS OF OYSTER BEDS.

Name of Bed.		Area. Sq. Yards.
Fishing Bay Beds	(Solid)	3,600,000
" " "	(Scattered)	25,605,000
Were Point Bed	(Solid)	1,845,000
Shark's Fin	"	1,867,500
Nanticoke Beds	"	3,465,000
Clump Point	"	382,500
Horsey's Bar	"	202,500
Tyler's Rock	"	675,000
Drumming Shoal	"	2,430,000
Cow and Calf	"	292,500
Bed East of Bloodworth Island	"	4,027,500
Cedar Rock	"	337,500
Turtle Egg Island Rock	"	1,620,000
Mud Rock	"	1,845,000
Chain Shoal	"	1,192,500
Muscle Hole	"	3,060,000
Piney Island Bar	"	6,975,000
Manokin River Beds	"	6,142,500
Big Annemessex	"	2,835,000
Harris' Rock	"	3,420,000
Terrapin Sands	"	1,417,500
Paul's Rock	"	765,000
Woman's Marsh	"	6,975,000
Rock Off Jane's Island Light	"	1,800,000
Great Rock	"	8,505,000
Little Thoroughfare	"	720,000
Great "	"	1,597,500
Oak Hammock Rocks	"	630,000
California Rock	"	3,915,000
Johnson's Rock	"	1,395,000
Brig Rock	"	517,500
Parker's	"	495,000
Beach Island	"	225,000
Hern Island	"	2,092,500
Bird Rock	"	3 285,000
Guilford Creek Rocks	"	1,642,500
Messongo	"	180,000
Muddy Marsh	"	1,912,500
Buoy Spit	"	427,500
Small Rock South of Shell Rock	"	225,000
Shell Rock	"	877,500
Trevise Rock	"	697,500
Drum Bay Point Rock	"	337,500
Dog-Fish Rock	"	720,000
Flat Rock	"	742,500
Small Rock North of Trevise	"	135,000
Slate Stone Rock	"	967,500
Potter's Rock	"	900,000
New Plantation Rock	"	180,000
Buoy Rock	"	967,500
Old Rocks	"	1,057,500

AREAS OF OYSTER BEDS.

TANGIER AND POCOMOKE—SUMMARY.	SQ. YARDS.
Total area in both Sounds occupied by oysters................	425,012,500
" " " " " " solid oysters beds......	92,520,000
Ordinarily Scattered....................................	313,345,000
Thinly "	19,147,000
	NAUTICAL SQ. MILES.
Tangier Sound.................................(Solid)......	17,101
" " ....(Scattered)..	44,926
Pocomoke Sound................... ....(Solid)......	4,519
" " ....(Scattered)..	29,599
Fishing Bay.................................(Solid)......	875
" " ....(Scattered)..	6,225
Total area both Sounds covered by oysters, or scattered oysters, in *square miles* (nautical)...............................	103,255

NOTE.—Those areas designated as "solid" are those where the proportion to the square yard fell below 0.1, or below one oyster to ten square yards.

PART II.

Extracts from Report of Investigations made from July 4th to October 20th, 1879.

The work of the party under my charge was properly the collection of such information as would conduce to the correct answers to the following questions:

1st. Were the oyster beds improving or deteriorating?

2d. What were the causes for such improvement or deterioration?

3d. How is the deterioration to be prevented or the beds improved?

In the endeavor to answer these questions it was necessary to investigate many problems and to collect much information having apparently but little bearing upon the main question, but it was my endeavor to limit the extent of the inquiry as much as possible and to direct all the energies of the party to the decision of the three points mentioned.

Though the biology of the oyster should be studied, yet only so much of it was essential to the work we had undertaken as would assist in the solution of the problem presented, and consequently it was desirable to leave an extended investigation in that line to others and to settle ourselves only such points as would, so far as we could see, directly assist us in arriving at correct conclusions.

The investigation conducted during the summer and autumn of 1878 had shown that the beds were deteriorating rapidly, and so far as could be seen the principal cause for this deterioration was the over-fishing of the beds. The remaining question to be answered was then, how the deterioration was to be prevented.

The main cause, as I have said, was decided to be excessive fishery, which, by removing too large a number of mature brood oysters, diminished in a constantly increasing ratio the fecundity of the bed. Other causes operated also to some extent, but their effects were inconsiderable.

There is but one method of maintaining the fecundity of the beds, and that is by protection, but this protection can be afforded in several ways: Either by restricting the fishery, by enlarging the field for the dredgers, or by insuring the maturity of a larger number of oysters, by artificially impregnating the ova of the female and protecting the resultant embryos during those periods when they were unable to protect themselves.

To afford protection and maintain the fecundity of the bed in the last mentioned manner has been attempted by Dr. W. K. Brooks, and his efforts have been in a measure successful. The ova has been impregnated, and the life of the resultant embryos has been maintained for varying periods, the maximum being six days.

Whether this success will be of practical benefit remains a matter of conjecture, and should it prove practicable to thus assist nature in maintaining the beds at their greatest productiveness, it will require extended experiments before we can feel assured that the protection afforded in this manner will be sufficient. To confirm the opinion as to the deterioration of the beds, and to show the best method of protecting them in the two remaining ways has been the endeavor of the party under my command, and to that result have our efforts been directed.

In the absence of positive and correct information as to the life and habits of the oyster, all legislation relating to their protection must be to a great extent inoperative and non-productive of the desired results, and until such information has been obtained the best and easiest remedy for the deterioration would be an extension of the known fishing ground; in other words, the discovery of new and well stocked beds, as the number of dredgers being, at least for a few years, constant, they will naturally seek the most profitable field for

labor, and leave the overworked beds for the newly discovered ones, thus giving the former a chance for recuperation. That this is the case is evident by the record of statistics, most of the dredging vessels working on the new beds outside the Sound and on those in the Potomac River on account of the poor returns given by the beds in Tangier and Pocomoke Sounds.

The protection afforded in this manner would, however, be but temporary, the demand for oysters constantly increasing, and the number of vessels working liable to increase with it. It may soon be necessary to legislate for the direct protection of the beds and to limit the supply by law before it is stopped entirely by nature It is well, therefore, for the best interests of all classes that such an amount of information should be collected, as to the character of the beds and oysters and the general conditions under which they advantageously live, as would direct protective laws into a channel productive of most good.

The first necessary information to be obtained, and of greatest moment, would be a knowledge of the positions and areas of the beds. No law could well be passed which would protect a bed whose position and boundary was not at least approximately known, nor could any study of separate beds or comparisons of many be undertaken without such knowledge. Again, since nature has already selected these areas as those most favorable to the growth and life of the oyster, they evidently are the best grounds upon which to deposit the young brood, should the experiments of Dr. Brooks prove successful and of practical importance.

It is hardly possible to enumerate all the advantages of knowing the positions and areas of the natural beds, and indeed it may safely be said that a thorough study of the oyster question would be impossible without it.

Of next importance is the knowledge whether at any time the bed is in a condition of greatest fecundity.

In the attempt to attain this knowledge the proportion of oysters to the square yard of the surface was ascertained during the season of 1878, as described by me in my previous

report. The results were of comparative value, and subsequent operations in each year were to show whether the oysters on the bed were increasing or diminishing, or in other words, the fecundity of the bed, as compared with previous seasons, was to be ascertained.

During the last season these proportions have been again calculated in a similar manner, but working with a greater knowledge of the subject generally, and a more correct estimate of the desired results, I have devised another method for ascertaining whether the bed is in its most productive condition.

It is evident that in any large community, when at its greatest fecundity, there must be certain ratios between the individuals of different ages, and that any change in these ratios will indicate an increased or decreased fecundity.

It was not, and probably will not be for some time, possible to separate the oysters into classes by ages, except in a very rude manner. The only indication of the age is the size of the animal, and the oysters were, therefore, separated into four classes, according to size, in the following manner:

The first class contained all those over three inches in length, and embraced all full grown, mature oysters.

The second class contained oysters between two and three inches in length, and these were supposed to be mature and fit for market, and between two and three years of age.

The third class contained oysters between three-quarters of an inch and two inches long, and represented the young growth of the preceding seasons, being thus oysters from six months to two years of age.

The fourth class contained all oysters under three-quarters of an inch in length, embracing the most minute that could be recognized, and represented the young growth of the last spawning season, or those of less than a year's growth.

By obtaining a sufficient number of each class from each bed it was intended to establish ratios between each class, which compared with ratios on new and comparatively unworked beds, would show whether the particular locality under examination was in a state of greatest productiveness

or not, and by comparing the ratios of successive seasons, the increase or decrease constant or otherwise, could be ascertained, and the yield of the bed in ensuing seasons predicted.

In order to have another and more correct standard for comparison, and to arrive at certain conclusions as to whether the spatting in any season was general and extending to all beds or confined to particular localities, and in order to know accurately the number of oysters surviving each period of their perceptive existence, numbers of spat collectors were deposited upon the different beds.

It was the intention to frequently inspect these tiles, and by counting the number of oysters on each tile at each examination the number of oysters surviving would be ascertained, and the age of the previously established classes would be decided.

Thus the life of a community of oysters, free from the dredging influence and protected from all but natural enemies, would be before us from the time of the first attachment until they reached maturity.

The study of their embryological life properly belonged to the zöological student, and the method of propagation and the successive stages of that life must be left to him to determine It is valuable to the inquiry under consideration, but not essential, as it is evident that we may neglect the early stages of life, and yet arrive at correct conclusions as to the number of mature oysters necessary to support the beds in their best condition.

In next importance to the knowledge of the absolute fecundity of the bed, is a knowledge of those conditions which would influence it, and in order that no cause for the deterioration should be neglected, and that all information bearing in any way upon the propagation and growth of the oyster might be collected, several matters of secondary importance have been subjected to investigation and the results embodied in either this or my previous report.

Included under this head are—

Investigations into the temperatures and the influence of

increased or diminished temperature upon the mature oyster and embryos.

Investigations into the character of the water, especially as regards its increased or diminished density and its extent.

Investigations into the character of the bottom and its influence upon the oyster.

A determination of the direction and velocity of the currents, and such collection of statistics of the oyster trade and fishery as would show its present condition and give a value to the dredging factor; and, lastly, a collection and study of the *fanna* of the beds, particularly of those animals supposed to affect the oyster.

An attempt has also been made to collect the experience of the oystermen and dealers, as to the habits of the oysters and as to the effect of the various changes of environment.

Having shown what, in my opinion, were the objects to be obtained, and the direction which the investigation should pursue, it remains now to describe in detail the work of the party in each branch of the inquiry and to decide upon the value of the results.

DELINEATION OF THE BEDS.

The beds in Tangier and Pocomoke Sounds were surveyed during the season of 1878 and described in my report of the operations of the party during that year. During the last season the survey of the beds has been but an incidental part of the work, only such having been delineated as time and circumstances would permit.

Those lying inside the Sounds have been subjected to an examination and survey similar to that of the previous season.

BEDS IN THE NANTICOKE RIVER.

These are small and inconsiderable, embracing a total area of 827,025 square yards.

Most of them lie on the eastern side of the channel and extend a short distance above Ragged Point, though detached groups may be found much further up the river.

The beds are small and the oysters and shells uniformly

spread over each surface. Each bed is very hard, and in most cases the probe would not penetrate beyond six inches.

When it was possible to push through the surface stratum a sub-stratum was found of sand.

The main part of the river bottom is of mud, and bottom of that description surrounds the beds. Along both shores the mud is firmer and of greater consistency than in the channel, and above Roaring Point and on those bottoms are placed large numbers of oysters transplanted from the Middle Ground bed and from other localities.

The river seems to be a favorite planting ground, and numbers of boats and canoes were working the Middle Ground bed during the summer in order to obtain the "plants."

The oysters are small, single, and in small clusters, and not of very good quality.

The water being shoal, from five to ten feet, no dredging could be done on these beds, and consequently the proportions to the square yard have not been calculated.

BEDS IN THE LITTLE ANNEMESSEX.

There are only a few small beds in this river and they are very seldom worked. Their total area is 463,951 square yards.

The oysters are in detached groups, separated by spaces of mud and sand, and are small, single, and in small clusters.

The depth of water varies from six to twelve feet.

BEDS IN KEDGE'S STRAITS.

The bottom of Kedge's Straits, from the sands on one shore to those on the other, is covered with scattered oysters to greater or less extent, but they are found in greater numbers in the channel on the soft bottoms than elsewhere.

The total area of the beds is 2,893,615 square yards, and three of them are of considerable size.

The first lies on the northward side of the Straits, north of Solomon's Lump Light House, south and southwest of the Western Islands.

It extends in a W. N.W. and E. S.E. direction (that of the

channel), and is $1\frac{1}{4}$ miles long and from one-eight to one-half mile broad, and is irregular in outline. Its area is 1,243,580 square yards.

Due west of this bed, south of Oyster Creek and N. N.W. of Fog Point is the second bed. It extends north and south five-eighths of a mile and east and west one-third of a mile. Its area is 645,705 square yards.

Southwest and west from this bed, and northwest from Fog Point, in the middle of the Straits, and west of the shoals, is the third bed. Its area is 550,045 square yards, and its greatest length N. N.W. and S. S.E. is three-fourth mile, with an average breadth of one-fourth mile.

The depth of water on the inner bed is from 12 to 16 feet, and on the two outer ones from 14 to 19 feet.

The oysters are spread in groups of different areas, separated by spaces of mud and sand, generally the latter, except close to the channel-way, where there is more mud.

The beds are in almost all cases very hard; when the probe would penetrate, however, soft sand was found.

The inner bed is much softer than the other two, and has a larger amount of mud.

The oysters were small and dark, single, and in small clusters of three or four, with no red sponge or grass.

On the outer beds the shells were lighter and cleaner than on the inner, and generally the oysters in the Straits are larger and with sharper bills than those inside.

INVESTIGATION OF THE CHESAPEAKE BAY WEST OF TANGIER AND SMITH'S ISLANDS.

The only information with regard to the ground outside the Sounds that could be obtained was, that there was a number of beds of different areas lying in the Bay, on the eastern side of the ship channel, especially about and on the shoals off Smith's Island and Kedge's Straits.

The ground being so little known, and the accurate delineation of the beds being so difficult when attempted with a sailing vessel, I considered it better to employ the limited time at my disposal in running tentative lines, off and on shore,

and other crossing lines over the ground, with a view to discover the location of the beds, and to mark these localities for a more thorough and exhaustive investigation in the future.

As it was then your intention to continue the investigation and delineation of the beds, I thought it preferable and a saving of time and labor to search for them first and afterwards survey them.

In accordance with this plan I dredged over the bottom of the Bay, from Tangier Island northward, running the lines sufficiently close to detect any beds of importance or the presence of scattered oysters.

The distance over which the dredge was dragged was always measured, and when the depth of water was not too great, the bottom was probed with a view of determining whether it was suitable for the oysters.

By reference to the projections it will be seen that these areas occur quite frequently on the shoal ground making off in a southwesterly direction from Tangier Island. That between Tangier Island and Cheesman's Islands there are, in the deep water, no oysters, and that from abreast Cheesman's Islands as far north as the investigation extended, there were found large areas upon which oysters were living, and in some cases in great numbers.

The depth of water does not appear to influence the formation or growth of these beds, some of them lying on the shoals and others in deeper water. Generally speaking, here as in the Sounds, the original beds were formed on the side of the shoals and wherever there was a sudden change of bottom.

Wherever the solid beds or "Rocks" were encountered they were found to be long and narrow ridges, extending generally in a northerly and southerly direction, except when near Kedge's Straits, where they ran more to the eastward and westward.

We could, in standing across the beds, but rarely obtain more than one or two hauls of the dredge before we were off the "Rock." The major axis appears here, as elsewhere, to lie in the direction of the current, and probably all natural

extension and growth of any bed is in that direction, the spat being carried backward and forward by the ebb and flow of the tides.

The large number of beds near and off Kedge's Straits is probably due to the large number of spat brought out from the Sounds through the Straits.

The bottom is generally of hard sand covered with sponge and grass. Near Kedge's Straits some mud sloughs were found, and in some cases the sub-stratum of the beds was of clay, but in most of them the stratum of oysters and shells was too thick and hard to be penetrated.

The beds outside the Sounds have been comparatively free from dredging, and thus present marked differences from those inside.

They are comparatively longer and narrower, and much more sharply defined. Very few scattered oysters are found near them, and the beds are much more solid, unbroken, and much harder, requiring heavier dredges than those used in the Sounds.

The most remarkable difference is, however, in the shape and growth of the oysters.

On the undredged beds they are long and narrow, with the lower shells very deep, and bills very thin and sharp. In no case did we find any single oysters of any class. All grew in clusters of from three and four to twelve and fifteen. The shells were clean and white and free from mud and sand. Generally there was found a tuft of red or white sponge attached to the clusters, and the mature first and second class oysters were covered, and the interstices between them filled. With those of the third and fourth classes numbers of barnacles were also found, and some *crepidula*, but *tubicola* were only present in small numbers.

The oysters found upon beds that have been much worked differ materially, being single and broader, in comparison to their length, round and with blunt bills. They are usually dark in color, and have a considerable amount of mud and sand on the shells. The sponges do not appear to be as abundant, and the amount of dredging on any bed may always be known by the appearance of the oysters brought up.

Upon an over-dredged and almost exhausted bed the oysters will be large and single, blunt-billed, with dirty shells, and an almost entire absence of sponges, barnacles and *crepidula* will be noticed, but the shells will be covered with *tubicola* and bored in many places by the *boring pholad.*

Late in the last spring the dredgers began working on the beds immediately off Kedge's Straits and the one off Hog Neck, and during the present season the returns show that the beds in the Sounds have been, to some extent, abandoned for those outside in the Bay.

As so little dredging was done before my examination, I think the results of the dredging operations of the party may be considered as obtained from unworked beds. These results will be alluded to subsequently.

Probably small beds will be found along the shores of the islands from Kedge's Straits to the entrance of Tangier Sound, but as the water was shoal I could not dredge very close in.

As far as can be seen at present there is no reason why the existing beds should not be extended very considerably, and such extension will probably take place now that the dredgers are beginning to work upon the beds. If suitable cultch is exposed, probably very large areas will soon be covered with oysters.

TABLE OF PROPORTIONS TO SQUARE YARD.

Locality.	No. of observ.	Proportions.
Section 1, West of Kedge's Straits..........	40	0.371
" 2, " Red House.......... ...	7	0.439
" 3, " White House...........	11	0.296
" 4, " Hog Neck..............	28	0.399
Mean of observations...............	....	0.375

The above table of proportions to the square yard has been compiled from all observations made in the Bay, when there was any evidence of a bed existing, such evidence being given by the probe, soundings, and character of the matter brought up by the dredge.

The proportions have been calculated in a manner similar to that described in my previous report, and are, as was pointed out in that report, only of value as forming a standard for comparison. It must be borne in mind, however, in making such comparison, that the hardness of the unworked beds and the closeness of the growth of the oysters would prevent as many being taken by the dredge as on the softer and more open beds in the Sounds.

By referring to the table, it will be seen that the proportion calculated for each locality is very nearly the same as that arrived at by combining all the observations, and that this proportion is about 0.4 to the square yard.

Accepting that as the standard, the proportion to the square yard upon a bed which has been dredged for some time should certainly not fall below 0.4, and considering the different characters of the bottom, the proportion, as shown by the dredge upon an old bed, should be much larger, unless the bed has been overworked.

The following table shows the number of oysters of each class examined, and also the number of bushels brought up and the percentage of shells and debris to the whole amount.

As will be seen by the table, the number of the fourth class of this year's growth is very large, showing that however bad the season may have been inside the Sounds it has not influenced the reproduction in the Bay.

DREDGING RESULTS. CHESAPEAKE BAY. TABLE No. 1.

LOCALITY.	Number Dredges.	1ST CLASS.		Ratios.	2D CLASS.		Ratios.	Number of Section.	3D CLASS.		Ratios.	Fourth Class.	NO. OF BUSHELS DREDGED.				No. of First-Class Oysters to the Bushel.
		Oysters.	Bushels.		Oysters.	Bushels.			Oysters.	Bushels.			Total Amount.	Bush. Oysters.	Bush. Debris.	Ratio Debris.	
West of Kedge's Straits.....	52	1018	8.8	1.49	1622	4.7	0 17	Sec. 1	1150	2.6	2 32	2674	23 7	16.1	7.6	0.32	115
West of Red House.........	12	359	3.0	1.00	360	1.0	0.88	" 2	318	0.7	1 41	447	7.2	4.7	2.5	0.34	115
West of White House......	15	135	1.1	1.07	145	0.4	0 16	" 3	23	....	2.15	50	3.	1 5	1 5	0 5	115
Hog Neck Rock............	106	1997	17.3	1.29	2579	7.5	1 08	" 4	2779	6.4	1.87	5200	42.2	31.2	11.0	0.26	115
West of Tangier Island......	15	37	0.3	1.30	48	0.1	1 06	" 5	51	0.1	3 74	191	2.2	0.5	1.7	0.77	115
	200	3546	30.5	6.15	4754	13 7	3.87		4321	9.8	11.49	8562	78.3	54.0	24.3	0.31	
Mean of Ratios.........				1.23			0.78				2.29						

0.75 per cent. of this year's growth.

In the foregoing tables the ground dredged over has been divided into parallel sections, and all oysters from the beds in those sections have been assembled together.

Section 1 includes all the beds west of Kedge's Straits.

Section 2 the beds west of that position on the chart marked Red House.

Section 3 the beds west of that position marked White House.

Section 4 the beds west of Hog Neck and Cheesman's Islands, and Section 5 the beds west of Tangier Island.

In compiling the tables I have entered only those hauls of dredges that have been taken on the beds or when the oysters were in considerable numbers. The scattered and detached groups and single oysters have not been considered.

Section 5 is not an important one, owing to the very small areas of all the beds encountered on it.

By examining this table it will be seen that a total of 54 bushels, amounting to 21,183 oysters, were examined; that from 200 hauls of the dredge we obtained 78.3 bushels of oysters and shells, and that 31 per cent., or 24.3 bushels of this matter consisted of shells or other debris.

This percentage does not differ materially from that found on each section.

Section 5 is not considered, as the percentage there does not entirely represent shells and other debris of the bed, but rather the sponge and grass of the sand shoals.

Regarding these beds as in their natural condition of healthy life, it is inferred from the deduced table that, other things being equal, a larger percentage of *debris* would indicate that the bed was not giving, for the same amount of labor, its natural return, or, in other words, that the mass of old shells brought up by the dredge was out of proportion to the number of oysters.

This percentage is of value as indicating the most profitable working grounds, and also as indicating, when very large, that the bed has been overworked and its population destroyed, as the percentage of shells bears the same relation to the oysters as the unoccupied dwellings in a city do to its in-

habitants; an increased percentage means a decreased population.

It is evident that there should be a certain proportion between the oysters of different ages, and in general terms the number of young should exceed the mature, thus allowing for the natural depletion in each period of growth.

Our present knowledge, however, is not sufficient to allow the assignment of exact values to these proportions, and the ratios between the different classes are too irregular, owing to the variations in the spawnings in the several seasons, to allow their acceptance as a standard.

One thing, however, may be assumed as an axiom, and that is that the number of young growth on a bed should always exceed the mature oysters, for if there are no young oysters in the community there will soon be no old ones, and as there is a constant depletion of each class, the young must sufficiently outnumber the old ones to allow these ravages and still adequately supply the demand and fill up the vacant places in the higher classes.

An inspection of Table 1 will show—

1st. That 0.75 per cent. of the 4th class were of this year's growth.

2d. That the ratios between the 3d and 4th classes are the largest, and between the 2d and 3d classes the smallest.

As the 2d class represents oysters of between two and three years of age, and, as the ratio between the 2d and 1st classes is large, I judge that there was a successful spatting on these beds in 1876; and as the 3d class represent, on the whole, oysters of the season of 1877 and 1878, and as the proportion between those of that class and those of the second is small, I infer that the seasons of 1877–78 were bad spawning ones.

Again, the 4th class are principally of this year's growth, and the ratio of 4th to 3d class is large, from which I infer what was the case, that the spatting of the last season on these beds was successful.

As already explained, the 3d and 4th classes practically represent the offspring of three successive spatting seasons, and thus contain the young growth on the bed, while the 1st and

2d classes represent the mature oysters. If, then, we compare the mature with the young, we have at once a sure indication of the state of the bed so far as its fecundity is concerned.

In order that the areas under consideration might be as similar as possible to the extensive beds inside the Sounds, I have only used for the following table the three largest sections—Nos. 1, 2 and 4:

DREDGING RESULTS. CHESAPEAKE BAY. TABLE I.

LOCALITY.	No. of Section.	Oysters. 1st & 2d.	Oysters. 3d & 4th.	Ratios.
West of Kedge's Straits.... ...	Section 1	2,640	3,824	1.06
" Red House...........	" 2	719	765	1.06
Hog Neck Bed................	" 4	4,576	7,979	1.70
		7,935	12,568	
Mean of Ratios.........	....	....	....	1.58

Accepting this mean ratio of all young growth to mature oysters, upon comparatively unworked beds, as the standard, it is inferred that it should not fall below 1.5 or 1.6.

FECUNDITY OF THE BEDS IN THE SOUNDS.

In order to ascertain whether the fecundity of the beds in the Sounds was the same as that of those outside in the Bay, a very thorough dredging was continued during the summer and autumn, and the oysters classified according to the plan already described.

The dredging lines are shown on the sketches accompanying the report, and were run over all beds where it was possible to carry the vessel.

The results are assembled in the following table:

DREDGING RESULTS TANGIER SOUND. Table I.

Locality.	No. Dredges.	1st class. No. Oysters.	1st class. No. Bushels.	Ratios.	2d class. No. Oysters.	2d class. No. Bushels.	Ratios.	3d class. No. Oysters.	3d class. No. Bushels.	Ratios.	4th class. No. Oysters.	Bushels Dredged. Total Amount.	Bush. Oysters.	Bush. Debris.	Ratio Debris.	No. of 1st class Oysters to a Bushel.
Middle Ground Nanticoke......	1	17		5.18	88		1.06	93		0.43	40					
Shark's Fin..........	57	382	2.9	1.28	489	2.3	0.92	453	1.6	0.92	418	10¼	6.8	9 4	0.58	246
Were Point.................	34	340		0 91	311		0.77	241		0.59	142	6				
		722			800			694			560	16¼				
Tyler's Rock................	14	102	0 5	1.45	148	0.4	0.39	59	0.2	0.49	29	3½			0.72	
Horsey's Bar................	2	15		1.06	16		1.37	22		1.14	25	½	1.1	2.9		
		117			164			81			54	4				
Drumming Shoal..............	39	666	2.	2 16	1439	4.20	0.91	1303	3.	0.47	607	12.5	10.2	2.3	0.18	220
Cow and Calf................	6	51	2.8	0.66	34	1.6	0.68	23	1.3			1.				
Grass Tangier...............	65	417		1.25	520		1.06	554		1.06	586	14¼	5.7	9.5	0.62	162
		468			554			577				15¼				
Turtle Egg Island............	54	375	2 3	2.4	900	2.6	1.57	1419	3.2	0.54	770	16.	8.1	7.9	0 50	
Mud Rock...................	53	521	3.2	3.03	1580	4.6	1.34	2121	4.9	0.52	1115	21.	12.7	8.3	0.40	

DREDGING RESULTS TANGIER SOUND. TABLE I—Continued.

Locality.	No. Dredges.	1st class. No. Oysters.	1st class. No. Bushels.	Ratios.	2d class. No. Oysters.	2d class. No. Bushels.	Ratios.	3d class. No. Oysters.	3d class. No. Bushels.	Ratios.	4th class. No. Oysters.	Bushels Dredged. Total Amount.	Bushels Dredged. Bush. Oysters.	Bushels Dredged. Bush. Debris.	Bushels Dredged. Ratio Debris.	No. of 1st class Oysters to a Bushel.
Chain Shoal	47	330	1 6	1.09	359	1.0	3.55	1374	3.1	0 70	966	21.	5.7	15 3	0.72	
Piney Island Bar	211	1282	6.2	3.0	3850	11.3	2.56	9857	22 8	0.41	4070	75.2	40.3	34.9	0.45	204
Muscle Hole	97	1176	7.2	2.34	2752	8.0	1.68	3876	9.0	0.48	1876	45.	24.2	20.8	0.46	
Manokin River	93	881	4.6	1.41	1282	3.7	0.48	2158	5.0	0 49	1169	26.2	13.3	12.9	0.49	188
Big Annemessex River	41	392	2.0	3.88	1521	4.4	1.21	1846	4.2	1.03	1905	29.2	10.6	18.6	0.63	196
Harris' Rock	108	559	2.7	3.11	1740	5.1	2.97	5174	11 9	0.62	3204	21.0	19.7	1.3	0.06	
Terrapin Sands	54	426	2.8	2.26	996	2.8	2 18	2110	4.8	0.61	1292	26.0	6 4	19 6	0.75	
Jane's Island	17	150	0.8	5.23	784	2 3	3.53	2771	6.4	0.43	1209	14.5	9.5	5.0	0.34	
Woman's Marsh	127	852	7.4	1.13	968	2.8	2.30	2229	5.1	0.42	947	65	15.3	49 7	0.76	115
Great Rock	152	1408	8.0	1.89	2665	7.8	3 02	8056	18.6	0.51	4153	116 5	34 4	82.1	0.70	176
Little Thoroughfare }	35	82 }	2.2	2.32	190 }	1.8	3.69	702 }	10.9	0.49	346 }	6.5 }	14.9	7.6	0.33	140
Great Thoroughfare }	33	230 }		1.90	438 }		9.15	4010 }		0.36	1483 }	16. }				
		312			628			4712			1829	22.5				
California Rock	82	663	3.3	0.93	620	1.8	1.75	1085	2.5	0 71	767	24.	7.6	16.4	0.68	196
Johnson's Rock	18	39	0.2	1.38	54	0.1	1.20	65	0.1	0.92	60	2.	0.4	1.6	0.80	

DREDGING RESULTS POCOMOKE SOUND. TABLE I.

Locality.	No. Dredges.	1st class. No. Oysters.	1st class. No. Bushels.	Ratios.	2d class. No. Oysters.	2d class. No. Bushels.	Ratios.	3d class. No. Oysters.	3d class. No. Bushels.	Ratios.	4th class. No. Oysters.	No. of Bushels Dredged. Total Amount.	No. of Bushels Dredged. Bush. Oysters.	No. of Bushels Dredged. Bush. Debris.	No. of Bushels Dredged. Ratio Debris.	No. of 1st class Oysters to a Bushel.
Dog Fish Rock	32	213		0.68	145		1.12	163		0.65	107	11.5				152
Trevise Rock	1	14	2.2	2.14	30	0 7	1.10	33	0.4	0.91	30	1.				
Shell Rock	31	88		0.42	37		0.38	14		1.78	25	31.	3 3	33.7	0.91	
Flat Rock	16	44		0.81	36		0.50	18		0.44	8	5.				
		....														
		359		0.69	248		0.91	228		0.74	170					
Muddy Marsh	22	59	0.3	0.2	12	0.03	0.75	9		1.67	15	14 2	0.3	13 9	0 97	
Bird Rock	60	237	1.2	0.19	46	0.1	0.37	17		3.23	55	50.	1.3	48.7	0.97	188
Hern Island Rock	39	180	1.0	0.34	61	0.2	3.62	221	0.5	0.16	36	23.	1.7	21.3	0.92	178
		417		0.26	107		2.22	238		0.39	91					
Parker's Rock	22	154	1.2	0 99	153	0.4	5.85	895	2.0	0 33	296	14.2	3 6	10.6	0.74	120
Brig Rock	23	166	1.3	0 57	89	0.2	1.07	95	0 2	0.52	50	77.	7.7	6.9	.77	120

By referring to Table I it will be seen that on all the beds in Tangier Sound, from Fishing Bay down to the Great Rock, with one exception, that of Chain Shoal, the maximum ratio is that of the second class to the first. The inference is that there was a successful spatting season on all the upper beds in 1876 or 1877, probably the former.

Again, the minimum ratio, as far down the Sound as the Mud Rock, is that of the third class to the second, showing that on the beds above the Mud Rock there was not a successful attachment in 1878, which was the case as attested by ourselves. The remaining ratios on these beds show that there has been some attachment during the present season.

Leaving the Chain Shoal Bed for the present, the minimum ratio on all the remaining beds is that of the fourth class to the third, showing that there has been but little attachment of young during the season of 1879.

The remaining ratios show that there was a partial attachment of young on the beds between Turtle Egg Island Rock and the Great Rock during 1878, and a partial attachment on the remaining beds north of Jane's Island during 1876 or 1877, while there was a successful spatting on those lower beds during 1878, which conclusion was found to be correct by our observations during that season.

Arranging these deductions in tabular form, we have the following:

TABLE *showing the success of Spatting in different Seasons—Tangier Sound.*

Year.	Section No. 1.	Section No. 2.	Section No. 3.
	Upper Tangier Beds down to Mud Rock.	Middle Ground, Turtle Egg Is., to Great Rock	Lower Tangier, below Jane's Island.
1876 or '77	Successful.	Successful.	Moderately successful
1878	Unsuccessful.	Moderately successful	Successful.
1879	Moderately successful	Unsuccessful.	Unsuccessful.

The Chain Shoal differs from the beds of its section, the upper, in having its successful spatting season in 1878, and its moderately successful one in 1876 or 1877, while during

the last season there has been but a small attachment; it thus assimilates itself to Section 3.

If Table I is again referred to for the Pocomoke Beds, it will be found by assembling the upper beds under one head and considering the Bird and Hern Island Rocks to be what they practically are, one bed, we have a table for Pocomoke, as follows:

TABLE *showing the success of Spatting in Different Seasons—Pocomoke Sound.*

Year.	Upper Pocomoke.	Muddy Marsh.	Bird and Hern Island Rocks.	Barker's and Brig Rocks.
1876 or 7..	Unsuccessful	Unsuccessful	Unsuccessful	Moderately successful
1878..	Successful	Moderately successful	Successful	Successful.
1879..	Moderately successful	Successful	Moderately successful	Unsuccessful.

With regard to these tables, it must be remembered that the success or want of it is only by comparison with previous years, nor does it necessarily mean that there has been even a moderate attachment, but only that one year was better than another.

By combining the 1st and 2d classes and 3d and 4th on each bed, and combining such beds as are similarly situated and contiguous, I have arranged the following table for comparison with the similar one of the dredging results on the beds in the Bay:

DREDGING RESULTS TANGIER AND POCOMOKE SOUNDS.

Table No. II.

Name of Bed.	Oysters. 1st & 2d.	Oysters. 3d & 4th.	Ratios.
Shark's Fin	871	871	1.0
Were Point	651	383	0.58
	1,522	1,254	0.82
Tyler's Rock	250	88	0.35
Horsey's Bar	31	47	1.51
	281	135	0.48
Drumming Shoal	2,105	1,909	0.90
Cow and Calf	85	23	0.25
Grass Tangier	937	1,140	1.21
Turtle Egg Island	1,275	2,189	1.71
Mud Rock	2,101	3,236	1.53
Muscle Hole	3,928	5,752	1.46
	8,326	12,340	1.48
Chain Shoal	689	2,340	3.41
Piney Island Bar	5,132	13,927	2.71
	5,821	16,267	2.79
Manokin River	2,163	3,327	1.51
Big Annemessex	1,913	3,751	1.96
Harris Rock	2,299	8,378	3.64
Terrapin Sands	1,392	3,402	2.44
Jane's Island	934	3,980	4.26
Great Rock	4,073	12,209	3.00
	5,007	16,189	3.23

The ratios underlined thus (......) are the only ones considered, and show the proportion of young growth to mature oysters in each locality.

DREDGING RESULTS TANGIER AND POCOMOKE SOUNDS.

TABLE No. II—Continued.

NAME OF BED.	OYSTERS. 1st & 2d.	OYSTERS. 3d & 4th.	Ratios.
Woman's Marsh..........	1,820	3,176	1.74
Little Thoroughfare........................	272	1,048	3.85
Great Thoroughfare........................	668	5,493	8.22
California Rock...........................	1,283	1,852	1.44
Johnson's Rock.................	93	125	1.34
	2,316	8,518	3.67
Dog Fish Rock...	358	270	0.75
Flat Rock..............................	80	26	0.32
Trevise Rock............................	44	63	1.43
Shell Rock..............................	125	39	0.31
	607	398	0.65
Muddy Marsh.............................	602	24	0.04
Bird Rock................................	283	72	0.25
Hern Island Rock........................	241	257	1.07
	524	329	0.62
Parker's Rock............................	307	1,191	3.87
Brig Rock................................	257	145	0.56

The ratios underlined thus (......) are the only ones considered, and show the proportion of young growth to mature oysters in each locality.

I find the ratio of young growth to mature oysters to be, generally speaking, a constantly increasing one from the head of Tangier Sound to the last section.

In my report of the investigation carried on in 1878, I called attention to the noticeable absence of "young" on the beds above Piney Island Bar and Kedge's Straits, and to the large attachment on the southern beds, and the ratios in Table II begin increasing materially on those beds where there was a successful attachment of young during the previous season.

Referring to the "Spatting Table," it will be seen that on the upper section there has not been a successful attachment since 1876 or 7; hence, the mature oysters from two to three years old, the growth of those seasons, should be in the ascendant naturally, and, hence, the small ratios on the upper section.

Apparently the ratios should be about the same on the middle section, as its successive spatting season was also in 1876 or 7; but the moderately successful season was in 1878, while on the upper section it was in 1879; and as brood oysters are constantly taken from the beds in constantly increasing numbers, it follows that the yield of each succeeding year will be less. As an additional cause, more of the beds in the upper section are worked during the summer than in the others.

During the season of 1878 there was an extraordinary growth of young on Harris' Rock, which accounts for its large ratio, and the increase of the other ratios over those of the first section is due, to some extent, to the attachment of the season of 1878.

On the lower section the ratios are very large, by reason of the successful attachment in 1878, and the but moderate success of the seasons of 1876 or 7.

The variations in the ratios can thus be accounted for by the success or failure of different spatting seasons, and no doubt this success or failure has its influence, but that its effects are not invariable can be seen by reference to the ratios of Pocomoke Sound.

With the exception of Parker's Rock, a small bed lying near Watt's Island, and which has not been dredged upon as

extensively as the others in Pocomoke Sound, we find the ratio of young growth to mature oysters exceedingly small. In no case do the former predominate. From this, according to the deductions from the Tangier Beds, it would be inferred that the seasons of 1876 or 7 were unusually successful ones for the attachment of the spat, and that subsequently there has been no successful season.

By referring to the spatting table, we find, however, that the spatting season of 1876 or 1877 was, on the whole, unsuccessful, and the seasons subsequent have either been successful or moderately so, and this conclusion is supported by our observations during 1878.

But as the success or non-success, as shown by the spatting table, is comparative only, we can only assume that whether successful or not the attachment was not sufficient as one explanation of the small ratios found in Pocomoke.

Consequently the variation in the success of different spatting seasons is not sufficient to explain unusual and abnormal changes in the ratios of the young growth to the mature oyster.

It is evident that the removal of a large number of mature oysters from a bed would show apparently an increased fecundity, by increasing the ratio of young growth to mature oysters, and this apparent increase would be observable for at least two years, or until the young growth became in turn mature, when, as the reproduction would naturally be diminished by the removal of the brood oysters, and consequently there would be a smaller number of young growth, and as the young growth of the previous year would be in that time mature, the ratio would suddenly turn in the opposite way, and be as abnormally small as it had been abnormally large.

Once having taken this turn, and the fishing still continuing, the ratios would constantly decrease. A few fluctuations might occur now and then, but the general tendency would be a diminishing one.

Nature arranges her own laws of supply and demand, and the proportions she establishes between the different classes in any community are most likely to be the necessary ones, and

such proportions are the only ones that can be accepted as standards.

We have established that upon the unworked beds in the Bay the ratio of young growth to mature oysters is about 1.5, but as this is the result of but one season's observations, and those over a somewhat limited area, it would be rash to accept that standard exactly or to draw rigid inferences from comparison with it.

In order to allow a sufficient margin for the variations of different seasons and localities, it will be better to consider the normal ratio as between 1 and 2, and, hence, any increase or decrease of those ratios will be an indication of diminished fecundity, and, consequently, all things remaining the same, the eventual destruction of the beds.

Comparing the ratios of the beds in the Sounds with that established as a standard, we find that—

1st. All beds above the Grass Tangier fall below the minimum ratio.

2d. That the groups including Tangier Grass and Muscle Hole are within the limit, as are the beds in the Manokin and Big Annemessex Rivers and the Woman's Marsh Rock.

3d. That all other groups exceed the maximum ratio.

4th. That all beds in Pocomoke, with the exception of Parker's Rock, are below the minimum.

Instituting another comparison, that of the percentage of debris to the total amount brought up, we find that with the exception of Drumming Shoal and Harris' and Jane's Island Rocks, the percentage constantly increases to the southward, and that in Pocomoke it is larger than elsewhere, and larger on the Muddy Marsh and Bird Rocks than on any others.

A coincidence will here be noticed in the increased ratios in lower Tangier and the increased percentage of debris, and, in Pocomoke, in the small ratios and very large percentage of debris.

TABLE OF PROPORTIONS TO THE SQUARE YARD—TANGIER SOUND.

Name of Bed.	No. of Hauls of Dredge.	1878.	1879.	Differences.
Horsey's Bar	6	....	0.254	....
Tyler's Rock	12	....	0.529	....
Were Point	50	1.254	0.840	—.414
Shark's Fin	80	1.014	0.328	—.686
Drumming Shoal	57	....	0.994	....
Tangier Grass	100	1.064	0.372	—.692
Turtle Egg Island	55	0.382	0.295	—.087
Mud Rock	52	0.642	0.515	—.127
Chain Shoal	41	1.539	0.242	—.296
Piney Island Bar	198	0.687	0.544	—.143
Muscle Hole	87	0.826	0.746	—.080
Manokin River	90	0.134	0.320	+.186
Big Annemessex River	4	0.560	0.665	+.105
Harris' Rock	109	0.281	0.423	+.142
Terrapin Sands	51	0.271	0.423	+.152
Jane's Island	14	....	0.670	....
Woman's Marsh	110	0.240	0.125	—.115
Great Rock	151	0.165	0.265	+.100
Little Thoroughfare	35	0.145	0.104	—.040
Great Thoroughfare	32	0.115	0.236	+.121
California Rock	79	0.212	0.261	+.049
Johnson's Rock	17	0.187	0.074	—.113

TABLE OF PROPORTIONS TO THE SQUARE YARD—POCOMOKE SOUND.

Name of Bed.	No. of Hauls of Dredge.	1878.	1879.	Differences.
Upper Pocomoke Beds	79		0.139	
Muddy Marsh	20	0.405	0.070	—.335
Bird Rock	58	0.360	0.124	—.236
Hern Island Rock	39	0.294	0.110	—.184
Parker's Rock	21	0.573	0.303	—.270
Brig Rock	23	.269	0.154	—.115

The proportion of oysters to the square yard ascertained, as described in my report of the investigation of 1878, has been calculated for each bed, and the results tabulated, together with those of the previous season, for convenience of comparison.

Though a standard has been established by the proportions

found on the unworked beds in the Bay, no comparison, except in one way, is just, the conditions of bottom and difference of growth upon the worked and unworked beds differing so materially.

The proportions on any bed, obtained by the method we have used, will always be much less than what is really the case, but they will be much less true on an unworked bed than upon one which has been for some time subjected to dredging influences, and where the bottom is soft and yielding, and the oysters grow singly or in small clusters instead of being cemented together and to the surface stratum, as they are on the undredged beds. Therefore any proportions obtained from a bed which has been worked should be larger than that obtained from an unworked one. How much so, it is impossible to say, but it is evident that a smaller proportion would indicate a failure of the mature oysters.

In calculating these proportions only first and second class oysters have been considered.

It will be seen by the table that on all the beds above Kedge's Straits there has been a marked decrease in the number of oysters to the square yard. That on the remaining beds, with the exception of Woman's Marsh and Johnson's Rocks, and considering the Thoroughfare Rocks as one, there has been an increase in the number of oysters.

That on all the beds in Pocomoke Sound there has been a marked decrease.

It will also be seen that on many of the beds the proportion falls below the standard of 0.4, that on none of them is it very much greater, and that generally speaking the proportions are less than the standard on those beds that show a gain upon the proportion established during 1878.

It would appear then, by one comparison, that most of the beds have not a sufficient number of mature oysters upon them; and by the other, that however many were taken off, yet nature could more than supply the demand.

These inconsistent results may be the result of several causes. The standard proportion may be too high, but, as has been explained, if the beds are in equally good condition,

the probability is that the dredge would bring up a larger number from the old than from the new beds.

The smallness of the proportions on the lower beds may be due to the greater depth of water and hardness of the bottom, though they do not differ greatly in that respect from the beds in the Bay, however much from those in the northern part of the Sound.

It would not be wise to decide hastily upon the evidence of the proportions, that the beds are either deteriorating or the reverse, especially as the comparison has been but of two seasons. If, after they have been continued for some time, there should be an increased proportion shown, it may be considered differently, but as all experience testifies to the deterioration of the beds, the inconsistency of the results shown by the table can probably be explained in another way than by assuming the standard proportion to be too great, and this explanation will be subsequently attempted.

INFORMATION OBTAINED FROM "SPAT COLLECTORS."

In order to ascertain when the first attachment of young took place on each bed, the comparative extent of such attachment, the influence of bottom and depth of water upon the attachment, and, finally, the increase in size of the oyster and the number surviving each period of their existence, I placed, early in July, twenty-four spat collectors on the beds in the Sounds.

It is a matter of regret that the collectors were removed by some ill disposed persons almost as soon as placed.

The last hurdle, as the bundle of tiles were called, was placed in position on July 14th, and on July 15th only four remained in position, and after the 1st of August there was but one left (No. 7, in the Big Annemessex River).

The hurdles were composed of eight or sixteen half round tiles, lashed on a wooden frame, and so arranged that the frame rested on the bottom, the tiles being thus raised about six inches above the surface.

The tiles were ordinary earthenware ones, unglazed, and were always placed so as to have their concave side underneath.

As long as the hurdles remained in position they were frequently examined in order to ascertain the advent of the young brood, and from these examinations I am of the opinion that the first attachment of oysters took place about July 17th, as on that day we discovered, with the aid of the microscope, oysters on Hurdle No. 12, on Chain Shoal, and on the 19th in the same way found them on No. 7, in the Big Annemessex.

On July 24th they were observable on the hurdles on the Great Rock, both in shoal and deep water, though the attachment probably began about the middle of July. Yet it was only evident on the tiles, as our dredging operations did not discover any attachment before the 12th of August, when the young brood were found in moderate numbers on all the beds in both the Sounds.

The number found in Pocomoke Sound was much smaller than in Tangier, and the number on the Upper Pocomoke Beds and on the Muddy Marsh Bed was smaller than on the lower ones.

The attachment appears to be proportional to the number of oysters, such beds as the Muddy Marsh, for instance, having very few young, but as the bed is badly broken up, this may be owing to the absence of proper cultch. The young appear to select the cleanest and smoothest shells for attachment, and we always found that the "boxes," or those shells which had not been separated completely, contained the largest number of young brood.

We also found that the size of the young depended, to a great extent, upon the depth of water. Those first detected by us were from two mil. to one cent. in length, and as the shoal water oysters spawn first, and as we found the young of the largest size in shoal water, I infer that the attachment of the oyster occurs very near the location of the parent.

The hurdle in the Big Annemessex was subjected to four examinations.

It was placed in position on July 9th, and on July 19th, when the first examination was made, there were a few oysters on the tiles, but so small that a microscope was necessary in order to recognize them (Record, Vol. I., Form B).

The second examination was on August 2d, and the oysters were then quite perceptible and easily counted.

The total number of oysters on the tiles was then 1,506; deducting those on tile No. 7, there were 1,177.

The number on each tile varied greatly, the maximum being 348 and the minimum 26.

The third examination was on the 23d of August. The oysters had increased very much in size and in numbers. The total number on the tiles was now 1,334, showing an increase of 0.13 per cent. of the number at the second examination. The number on the lower side of the tiles was much larger than on the upper.

A tile (No. 2) was removed, and, deducting the number of oysters on it from the sum, there were 1202 still on the hurdle.

There were a few oysters injured, probably, by raising or lowering the hurdle from and to the bottom.

The fourth examination was on the 10th of October.

The total number of oysters was then 539, showing a decrease of 55 per cent.

At this examination about two-thirds of the oysters were of the third class, or over three-quarters of an inch in length, and two of them were over two inches long, being thus of the second class. All, however, could be distinguished as of very recent growth, being very long and thin, with thin, delicate shells, easily broken with the thumb-nail or point of a penknife.

The largest numbers were still found on the lower sides of the tiles.

A moderate number of oysters had been injured by rough handling.

I infer from the four inspections made of this hurdle, and from the one or two made of others before they were removed, that the first attachment of young began, as I have said, about the middle of July, and continued until about the twentieth of August, as on the 23d of that month there was no indication of any recent attachment. Probably it reaches its

maximum number about the end of July, and decreases afterwards.

The mortality after the 23d of August was very great, fully 50 per cent. perishing from some unknown cause, which, though unknown, is certainly natural.

We did not notice any evidence of the destructive effects of drills or other animals, though as their agency would only be discovered by the evidence of the holes in the upper valves, but as those valves were never present, it cannot be said with certainty that the destruction was not due to them. Whatever the cause, the fact is that 50 per cent. perished in the first six weeks of their existence.

The tiles have shown that the increase in size is much greater than was supposed, and are the first and only authentic evidence upon that point which has been produced with regard to the American oyster.

Again, it is conclusively shown by these tiles, and some others that were dredged up from the Woman's Marsh Rocks (Hurdle No. 24), that the greatest attachment is on the lower concave side, and consequently that whatever may be the movements of the embryo oyster before attachment, during the period just prior to it, they are near, if not on the bottom, and in seeking their place of attachment they must rise. In this they are similar to the European variety.

The selection of the lower sides of the tiles and the interior of the "boxes" may be an effort of nature to provide some protection for the young brood by, to a certain extent, inducing them to seek dark and secluded points for attachment, or the large number found in such places may be due to the inability of the various enemies of the spat to get at them when thus protected.

It is a matter of very great regret that we have not a large number of specimens and observations for comparison, as all the future investigations in this field would be greatly assisted by an accurate knowledge of the rate of decrease in number and increase in size of the oysters, and it is to be hoped that the hurdle in the Big Annemessex will be allowed to remain

in position long enough to permit the meagre yet valuable information it can produce to be made public.

INVESTIGATION OF TEMPERATURES.

It was intended that a self-registering thermometer should be placed on each hurdle, and that the temperature to which the young were exposed should be noted at each examination. Fortunately, considering the fate of the hurdles, the thermometers were not received in time to be used, as was intended, and after the disappearance of the spat collectors it was not considered advisable to expose the thermometers to the same risks.

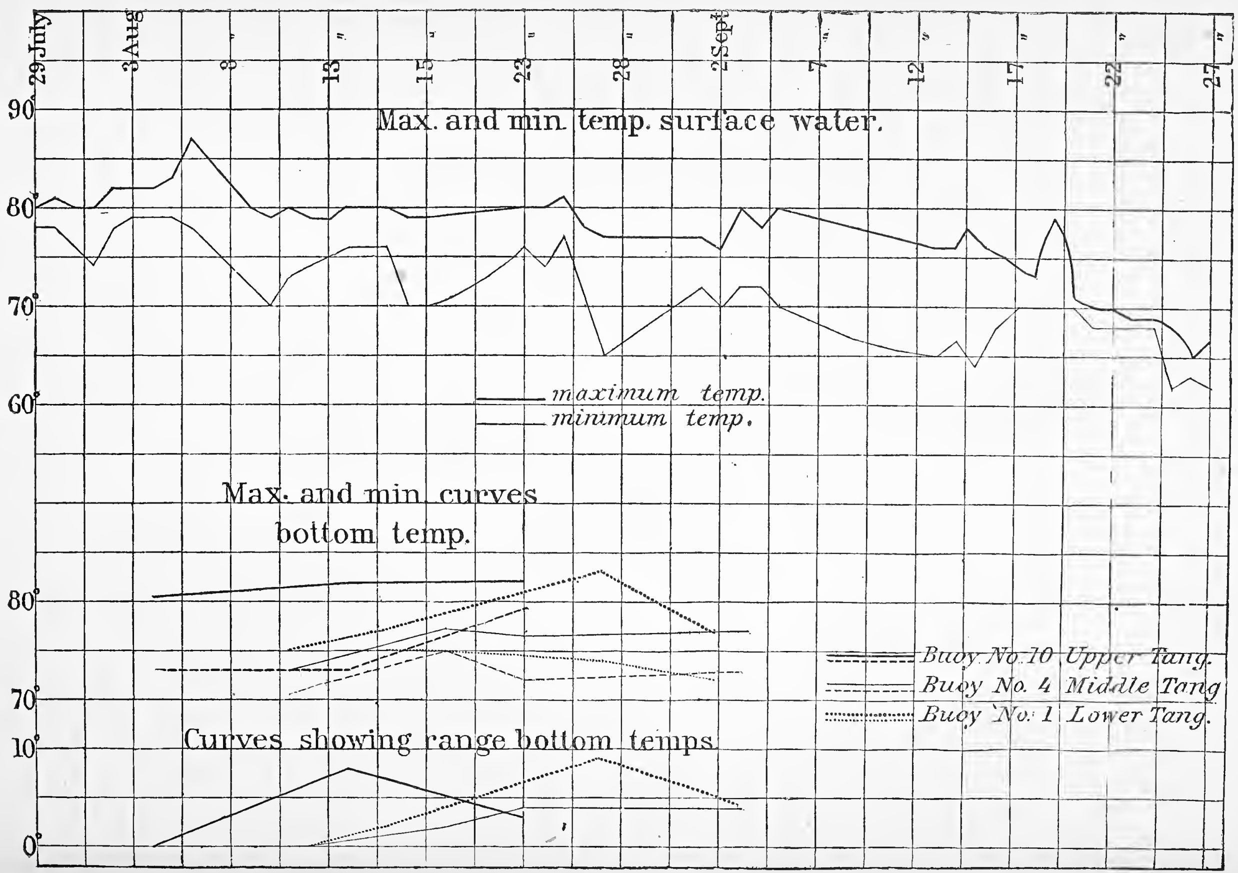
About the last of July, however, I had the temperature of the surface water recorded every two hours, and considering that there is probably but very little variation of those limits in the Sounds, I have plotted the accompanying curve of maximum and minimum temperatures from July 29th to October 1st.

It will be seen that these curves are very irregular, and that the greatest irregularities occur during the month of August, and that the greatest difference is between the 6th and 10th of August, one of 15° in four days. On the 15th there is a change of 8°, and on the 28th of 12°.

About the 4th of August I determined to utilize the channel buoys as marks for the positions of thermometers, hoping that they might thus escape the observation of those who were inclined to remove them. Accordingly I placed four self-registering thermometers on the beds—one at the foot of the buoy on the Shark's Fin, one on the buoy on Piney Island Bar, one on the buoy off Watts' Light House, and one on the buoy off Sykes Island, about the middle of Pocomoke Sound.

We were enabled to make several examinations of these thermometers, but about the 1st of September, finding that one had been stolen, I concluded to remove the others before they shared the same fate.

The curves of maximum and minimum temperature given by these thermometers, and also the range of variation, are


29 July
3 Aug
8 "
13 "
15 "
23 "
28 "
2 Sept
7 "
12 "
17 "
22 "
27 "
90°
80°
70°
60°
Max. and min. temp. surface water.
maximum temp.
minimum temp.
Max. and min. curves
bottom temp.
80°
70°
10°
0°
Curves showing range bottom temps.
Buoy No. 10 Upper Tang.
Buoy No. 4 Middle Tang
Buoy No. 1 Lower Tang.

shown on the same sheet with the curves of surface temperature.

The thermometers were in place too late, and for too short a period, to allow any safe conclusions to be based upon the information given by them, but it is noticeable, as an interesting coincidence, that the curves of both surface and bottom temperatures show the greatest variations about the time when the young were what is known as "spat," or during the period of, and just before, attachment, the young on the shoal beds presumably attaching by early August, and those on the deep water or southern beds somewhat later.

I regret that it was impossible for me to more thoroughly study the effects of the change of temperature, as I think the failure or success of the spatting, other things being equal, will be found to depend mainly upon the temperature to which the mature oyster and embryos are exposed during the spawning seasons.

INVESTIGATION OF THE CHANGES IN DENSITY OF THE WATER.

In order to have definite information as to the change of density of the water surrounding the oysters, and regarding such changes during the spatting season as of most importance, and as the maximum change would be most likely to occur about the time of the spring tides, I determined to obtain several specimens of water on a certain number of sections across each Sound at high and low water of the spring tides.

The sections were located as follows, and are shown on the sketches accompanying this report:

Section No. 1 was just above Hooper's Straits and at the mouths of the Nanticoke and Wicomico Rivers, in order that the influence of both the straits and rivers might be shown.

Section No. 2, for the same reason, was north of Kedge's Straits and across the mouths of the Manokin and Big Annemessex Rivers.

Section No. 3 was across the entrance of both Sounds, south of Watts' Island.

Section No. 4 was across the middle of Pocomoke Sound, that the influence of Guilford and Messongo Creeks might be known.

Section No. 5 was above the natural beds of Pocomoke Sound and across the mouth of the Pocomoke River.

Stations were selected on these sections in such a manner as to obtain specimens of the water that passed over the beds, and the specimens were taken by means of the drop water cylinders at every two fathoms of depth.

As soon as possible after securing them they were tested with the hydrometer. The results are tabulated in the "Record of Densities" and curves showing the various changes accompanying this report.

All densities are reduced to a standard temperature of 60° Fah., and 1,000 represents the density of distilled water.

In studying these curves, it must be remembered that only their variations are of particular importance. The absolute density is not so much so, except for comparison with that of other localities, but the variations in density are important, if by them we can account for the failure either of the propagation or attachment of the young oysters.

The curves will show certain irregularities due to either the variations in depth, or because the tide having changed from flood to ebb, or the reverse, on one side of the Sound at a time differing from that on the other.

As will be seen, however, the greatest variations in each month are in Tangier Sound, on the eastern side, where the influence of the rivers is felt to greatest extent.

In Pocomoke Sound the greatest variations appear to be on the western side, and I assign as a reason for this that the influence of Guilford and Messongo Creeks is of small importance compared with that of the Pocomoke River, the current from which sweeps along the northern and western parts of the Sound.

The curves show that the variation is very slight, except on the September sections.

The second series of curves, those showing the monthly changes of mean densities, indicate that the maximum change

on each section was about the 1st of September; that the variations in Pocomoke Sound were much greater than in Tangier Sound, and that the maximum changes were at the head of each Sound, and the variations diminished towards the entrances.

The third series of curves shows the same when all the observations in each Sound are assembled, but with this difference, while the density in Tangier Sound was greater on October 1st than at any other time, in Pocomoke Sound the influence of the river was still felt, and notwithstanding the diminished temperature the density on the 1st of October was less than on the 1st of August.

The fourth series of curves shows the difference in density between the upper and lower sections in Tangier and Pocomoke Sounds in each month, and indicates that the density of the water is considerably greater over the lower beds than on the upper.

The maximum density found during the summer was on section 3, in October, and was 1.0166.

The minimum density was found in section 5, in September, and was 1.0005.

By referring to the curves showing monthly changes of *mean* densities, it will be seen that in only one case, that of Section 5, does the density become less than 1.0100, and that even on this section it is evident that this was not the normal condition of the water.

There were heavy freshets in the Pocomoke River during the latter part of August and during September, which accounts for the slight density, as shown by the curves.

Mr. Barroll was informed by the inhabitants of the vicinity of the mouth of Pocomoke River that these freshets had killed large numbers of oysters, both on the natural and planted beds.

An inspection of the other curves shows that the variation of density on successive tides was not much greater on this section than on the others, and as the oysters elsewhere in the Sounds did not appear to suffer from the effects of these variations, I am of the opinion that the fluctuation was not suffi-

cient to affect the mature animal, but that in this case the water continued fresh, or practically so, for too long a period, thus killing the oysters by endosmose.

From the observations of density, then, it may be assumed that the density of the water in these localities at least cannot fall below 1.01 for any protracted period without destroying the oysters.

Whether the changes in density affect the spatting can only be ascertained by continuing the observations for a number of seasons, or by direct experiment with the spat artificially raised.

During the summer I have examined, under the microscope, 374 oysters, of which 212 were females and 162 males, or the percentage of females to males was 0.56.

The oysters were not all examined at the same time, nor were they all from the same bed, but the percentage in each of the lots examined, twelve in number, does not vary greatly from the percentage given above.

I am of the opinion, therefore, that about 60 per cent. of the oysters in a community are females. A larger number of observations is, however, desirable.

In making these examinations I have never seen both ova and spermatozoa in the same animal, though I have made many careful observations in order to detect the presence of either. I have also carefully examined the gills and mantles of a large number, and have never found an embryo oyster within the shell.

As these observations were made during the spawning season, I do not think it possible that the spat, if they are at any time contained within the gills or mantle, could have escaped my notice.

The observations as to the sex of the oyster were continued late in the season, and though the ova and spermatozoa in a number of oysters was in apparently good condition as late as the 1st of October, yet those products of generation appeared in best condition in the largest number of animals during July.

A considerable disintegration of the eggs was noticed by

the end of that month, as far as I could ascertain the condition of both ova and spermatozoa depended upon the depth of water, though the rule was not invariable.

The generative products of the deep water oysters reached a state most favorable for reproduction several weeks after the same had occurred in the shoal water; and, in general terms, neither ova nor spermatozoa in most of the oysters in either deep or shoal water after the middle of August was in a state favorable for fertilization.

Large numbers of oysters in all depths passed through the spawning season without expelling the contents of the generative organs. I found this the case especially on the beds on the western side of Tangier Sound, above Kedge's Straits, where, on the 8th and 9th of October, we found many oysters fattening with the generative matter unexpelled. I was informed that this was not unusual, and that it injured the oyster for marketable purposes.

As late as the 8th I found oysters with the generative matter in good condition, and on the 7th of October I succeeded in securing from oysters taken from Kedge's Straits a sufficient amount of ova and spermatozoa to make experiments in artificial impregnation, and was successful in producing one embryo oyster.

Probably had I used greater care a larger number would have resulted.

During the season of 1878 we observed large numbers of *astyris* in the shells of the mature oysters, and attached to those of the young. In many cases they were found in the holes which had been bored in the shells of the latter.

As we could not find any known enemy of the oyster in sufficient numbers to account for the evident damage done, and as so many circumstances pointed to the *astyris* as the cause, I concluded that the boring must be done by that animal, and alluded to it in my previous report. The specimens preserved were described by Mr. W. H. Dall, and the description appended to that report.

During the past summer we have found a much larger number of the rough welks (*urosalpinx cinereus*) than during the

previous season, and though they were not found in as large numbers as the *astyris*, yet their presence inclined me to question the conclusions arrived at during the season of 1878.

I accordingly collected a large number of the *astyris* and placed them in an aquarium jar with a number of young oysters, changing the water constantly and inspecting the animals frequently.

These observations were continued for over a week, and at the end of that time both oysters and *astyris* were alive, but there was no evidence of any boring, nor did any inspection show an inclination in that direction upon the part of the *astyris;* on the contrary, they soon left the shells and went to the bottom of the jar.

I then collected a number of *urosalpinx cinereus* and subjected them to the same test.

At the end of four days one oyster had been bored and one welk was found at work on the shell of another.

The rough welk is known to do great injury to the oyster in Long Island Sound, and the destruction of the young alluded to in my previous report, as due to the drills, may be effected by this animal.

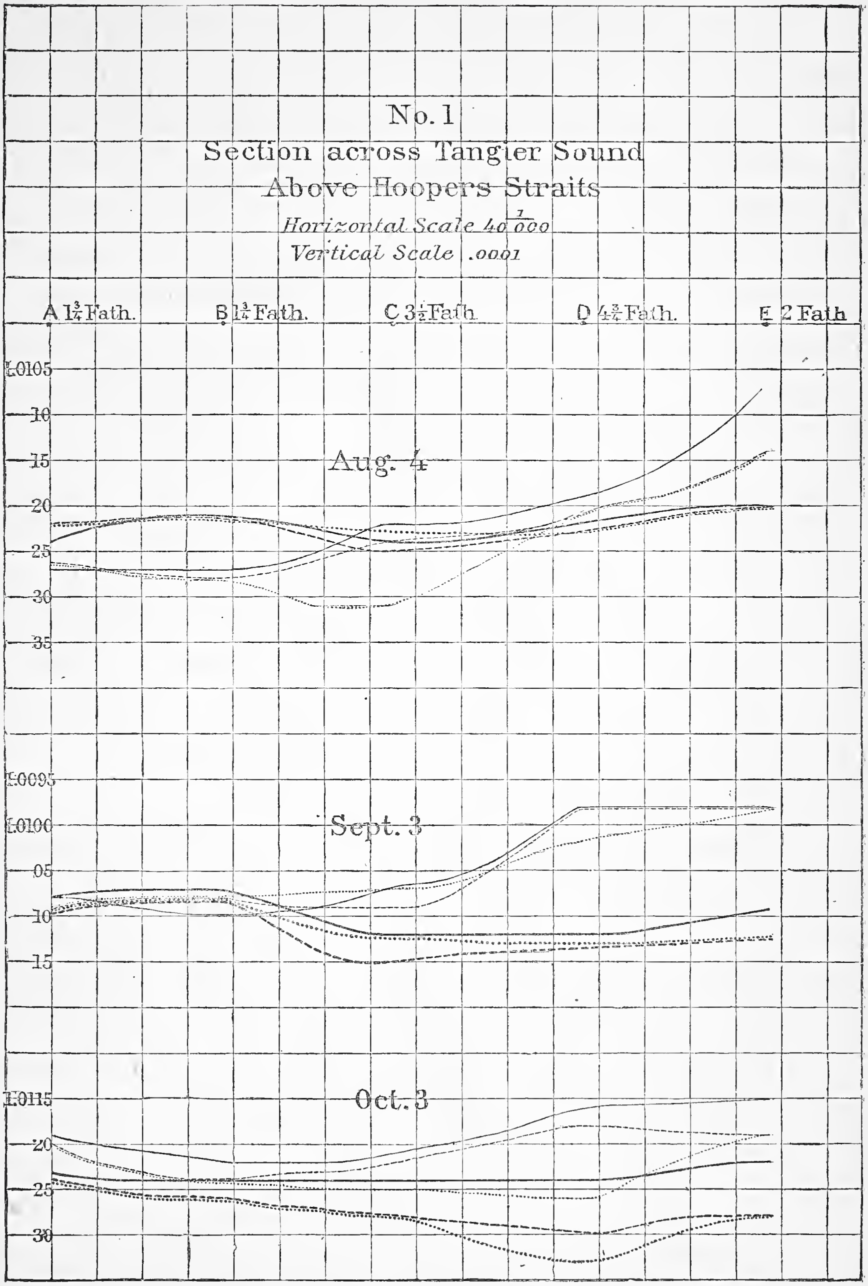
That large numbers are destroyed by the welks cannot be doubted, but it is possible that the *astyris* may also assist in this destruction.

A more extended investigation of this question than I was enabled to make is desirable.

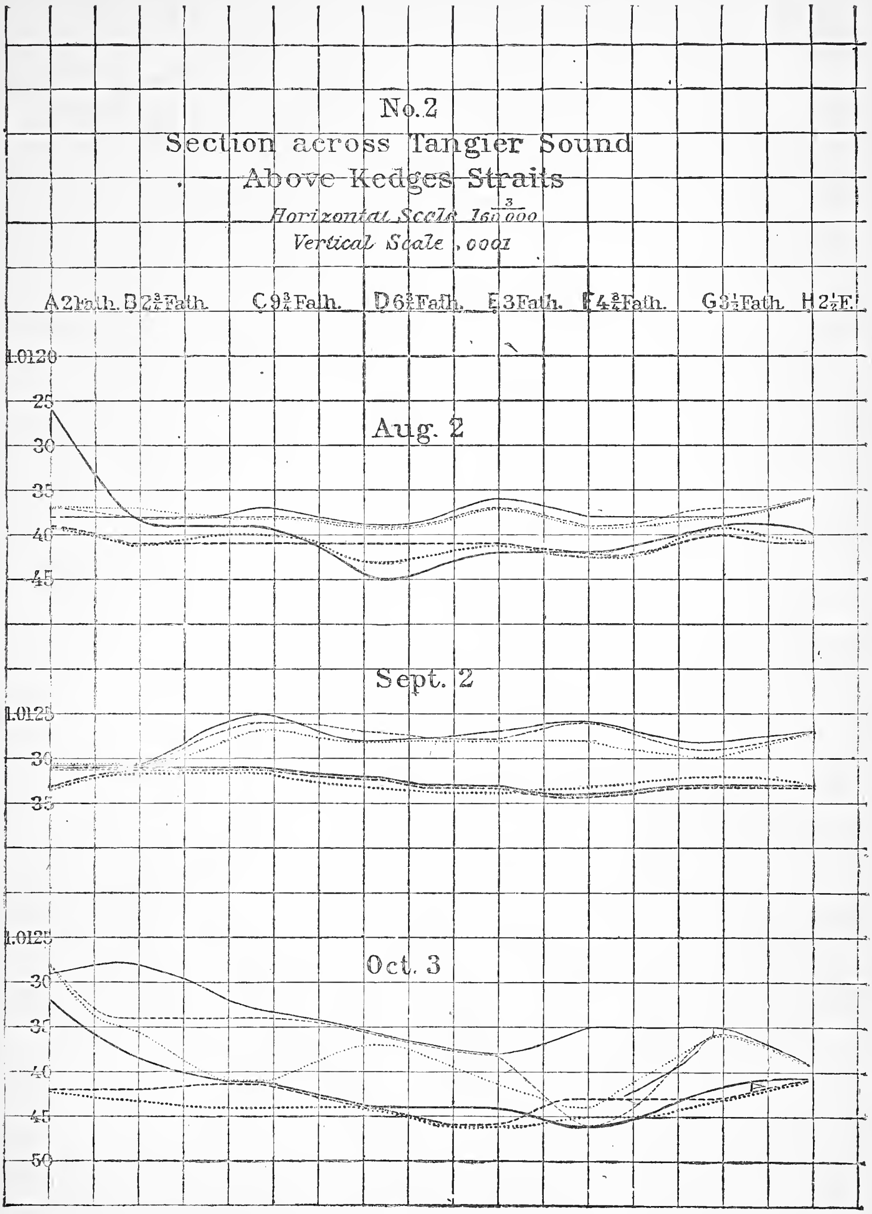
An analysis of several specimens of the water of the Sound and of the Bay, made by Prof. C. E. Monroe, of the Naval Academy, is appended to this report, for use in comparing the localities investigated with others whose investigation may be subsequently attempted.

The specimens have been selected from those taken in different stages of the tide and from different sections.

The only noticeable change on the beds this season was that the amount of red sponge appeared to be much less than in 1878. In other respects they are, to outward appearances, in a similar state, though the dredgers report them as much broken up, with an increased amount of debris.



No. 1
Section across Tangier Sound
Above Hoopers Straits
Horizontal Scale 1/40000
Vertical Scale .0001
A 1¾ Fath.
B 1¾ Fath.
C 3½ Fath.
D 4¾ Fath.
E 2 Fath.
1.0105
10
15
20
25
30
35
Aug. 4
1.0095
1.0100
05
10
15
Sept. 3
1.0115
20
25
30
Oct. 3


No. 2
Section across Tangier Sound
Above Kedges Straits
Horizontal Scale 3/160000
Vertical Scale .0001
A 2 Fath. B 2¾ Fath. C 9¾ Fath. D 6¾ Fath. E 3 Fath. F 4¾ Fath. G 8½ Fath. H 2½ F.
1.0120
25
30
35
40
45
Aug. 2
Sept. 2
1.0125
30
35
1.0125
Oct. 3
30
35
40
45
50

INFORMATION OBTAINED FROM "RECORD OF STATISTICS."

The member of the party on duty at Crisfield inspected, during the season, 496 vessels directly engaged in the oyster fishery, and the results of these inspections have been recorded in the Record of Statistics, which record, to a great extent, explains itself.

Owing to the large number of vessels dredging, it was frequently impossible to visit and inspect all that entered during the day. When such was the case, those inspected were selected from different classes and from different dredging grounds that a fair idea might be obtained of the number of oysters removed each day from each bed.

The method of examination was as follows:

The total number of bushels in the load given by the master of the vessel was recorded, and with the number of hours of labor necessary to obtain that quantity, and other matters of statistical interest.

Several samples of one-quarter or one-half bushels each were then selected from different parts of the load, and the number of oysters in each sample of each class counted and recorded. The number of samples examined depended upon the number of bushels in the load and upon the character of the oysters, a large number being taken when the oysters appeared dissimilar, and when the quantity was great. At least three samples were usually examined.

In most cases the average number of each class per sample was nearly the same as that given by each term, and, consequently, it is assumed that a close estimate of the number of each class in the entire load was obtained by multiplying the number of each class in a bushel, as shown by the samples, by the total number of bushels in the load.

From the record of these inspections I have been able to determine with practical accuracy the number of oysters of the several classes removed from the various beds by each description of dredging vessel.

After September 1st, when the dredging began, we counted each day all the vessels in sight from the "Palinurus," specifying the size and the ground upon which they were working,

and the masters of the dredging vessels were also requested to note the number of dredgers working in their vicinity, which they in many cases very obligingly did.

As even with this *data*, the number of working days given on each bed is very small, and because no bed is dredged continuously during the season, but at intervals, I have divided the sections in a similar manner to that described in my previous report.

The first section includes the beds north of Piney Island Bar and the Muscle Hole.

The second section, those from the Muscle Hole and Piney Island Bar to the Great Rock.

The third section the remaining beds in Tangier Sound, and the fourth section all the Pocomoke Beds.

By this arrangement duplication of the vessels counted is prevented, and the average number of vessels working each day is more nearly a correct estimate.

The vessels dredging on these several sections, as counted by ourselves and by their masters, have been assembled; the number of oysters assigned to each class of vessel working in the section has then been multiplied by the number of vessels of each class, and the total number of oysters taken off the beds in each section thus obtained.

The number of oysters taken by any vessel in a day varies greatly, owing to the weather principally, but in assigning the quantity on each day, the number brought in by vessels of the same class, as shown by "Record of Statistics," has been used, as a more correct estimate is thus assured than would be given by using the average for the whole season.

The following table has been compiled from the calculations, and shows the number of oysters taken from each section in a specified number of days, and supposing the observations to have extended over a sufficient period, the number of oysters has been divided by the number of days, and the average number removed in each day thus obtained:

TABLE SHOWING ESTIMATED NUMBER OF OYSTERS REMOVED IN 1879.

Section 1, Upper Tangier Sound.

	No. Sail.	1st Class.	2d Class.	3d Class.	4th Class.	1st and 2d Class per sail.
Total No. of oysters removed in 12 days	By 521 sail	2,322,200	1,934,200	1,382,500	371,000	8100
Average per day		192,683	161,183	115,200	30,916	
Total 1st and 2d per day		353	866			

Section 2, Middle Tangier Sound.

	No. Sail.	1st Class.	2d Class.	3d Class.	4th Class.	1st and 2d Class per sail.
Total No. of oysters removed in 17 days	By 634 sail	2,463,800	1,623,860	1,132,060	384,220	6400
Average per day		144,929	95,521	66,591	22,600	
Total 1st and 2d per day		240	450			

TABLE SHOWING ESTIMATED NUMBER OF OYSTERS REMOVED IN 1879—Continued.

SECTION 3, LOWER TANGIER SOUND.

	No. Sail.	1st Class.	2d Class.	3d Class.	4th Class.	1st and 2d Class per sail.
Total No. of oysters removed in 34 days	By 951 sail	2,329,600	1,413,610	1,407,230	558,900	3900
Average per day		68,223	41,576	41,389	16,438	
Total 1st and 2d per day		109	799			

SECTION 4, POCOMOKE SOUND.

	No. Sail.	1st Class.	2d Class.	3d Class.	4th Class	1st and 2d Class per sail.
Total No. of oysters removed in 9 days	By 169 sail	256,809	121,103	88,800	20,108	2200
Average per day		28,534	13,567	9,866	2,234	
Total 1st and 2d per day		42	101			

Total No. of oysters removed in one day 746,226

It will be noticed that the number of dredging vessels increases on each succeeding section in Tangier Sound, but that the number taken by each sail, and the yield per day, decreases. Also that the number of sail in Pocomoke Sound is much smaller than in any other section, and that the yield per day is also much smaller.

The character of the bottom and the depth of the water materially influences the yield of the bed, those in shoal water with soft bottoms allowing more frequent hauls of the dredges than those in deep water or on hard bottoms. But as the dredges used in deep water and on hard bottoms are usually much heavier, this inequality is overcome to some extent.

Again, the large vessels take a greater proportion of the oysters than the small ones, and those large vessels usually work on the deep water beds.

Considering the different sizes of the vessels and the superiority of the crews of the larger ones, and the heavier dredges used by them, I am of the opinion that the disparity between the yields of the Upper and Lower Tangier beds is greater than it should be.

The beds of the Middle Section are, with the exception of Piney Island Bar, similar to those of the upper section; yet, with a larger number of vessels working, the yield of that section is less than the upper.

These facts, I think, show that the beds in Lower Tangier Sound are less productive than those in the upper.

The dredging in Pocomoke Sound was principally on the upper beds, and none was done as far as we could ascertain on either the Brig or Parker's Rocks.

As the middle and upper beds in this Sound are very similar in character of bottom and depth of water to the middle and upper beds in Tangier Sound, it would be inferred that the yield per day in Pocomoke would be about the same. On the contrary, as shown by the table, it is absurdly small; and, considering its size, it is not astonishing that the beds have been to a great extent abandoned.

Taking the number of oysters removed each day, and considering, for the reasons give in my previous report (Vol. 2—con-

clusions), the working season to be of 120 days, I have compiled the following table, in which are given the number of oysters removed from each section and from the Sounds in one day and in the season. I have also given the same estimated in 1878 for comparison.

TABLE *showing the number of Oysters Removed.*

Section.	In One Day.		In One Season.		1879. Number of Young Growth.	
	1878.	1879.	1878.	1879.	Per Day.	In the Season.
No. 1........	567,450	353,876	68,094,000	42,465,120	146,100	17,532,000
" 2........	378,450	240,450	45,414,000	28,854,000	89,200	10,704,000
" 3........	459,000	109,799	55,080,000	13,175,880	57,800	6,936,000
" 4........	133,650	42,101	16,038,000	5,052,120	12,100	1,452,000
All Sections..	1,538,550	746,226	184,626,000	89,547,120	325,200	36,624,000

The estimated number of young removed from all sections in one day, in 1878, was about 1,240,000, or 148,800,000 in the course of the season.

It will be seen by the table that about one hundred million more oysters were removed in 1878 than would be in 1879, and that about the same excess exists with regard to the young.

Of the two estimates, that of 1879 is much more accurate, being based upon a larger number of observations, more carefully and systematically taken, than was possible in 1878, but the disparity between the two is so great that the estimate of 1878 would appear valueless, could not some cause be assigned for a decrease in the number of oysters taken from the beds.

This decrease, as may be easily seen, must be due to one of the following causes or to both.

1st. The fertility of the beds remaining the same, the dredgers may not be as numerous.

2d. The number of dredgers remaining the same, the beds may be exhausted; or, becoming so, consequently there would be a smaller number of oysters produced.

3d. The number of dredgers may have decreased and the fertility of the beds may be greatly impaired.

There are no statistics of the oyster fishery in the localities under consideration except those collected by myself, and I am consequently obliged to put a greater dependence upon them than they intrinsically merit. They are necessarily somewhat rude, but in the absence of other information they can be used as giving some indication of the probable progress of the fishery in the two seasons under consideration.

By examining my previous report (Appendix C) it will be seen that in thirteen days we counted 1595 vessels working on the various beds in both Sounds.

From our records of the past season I find that the number observed by all persons was, in thirty seven days, 2275, or in 1878, the average number working on each day was 122, while in 1879 it was 61, or about one-half as many.

Therefore, the small yield of the beds during the autumn months of 1879, and the small estimate of the yield for the year, may be accounted for by the smaller number of vessels at work.

As in round numbers the number of oysters estimated as taken in 1879 was about one-half that estimated in 1878, I think that the previous estimate may be accepted as practically correct.

My last advices from Crisfield inform me that there is but very little dredging going on in the Sounds, most of the vessels working in the Bay and in the Potomac River. The principal cause assigned for this is, the presence of young growth on the beds, by which is meant immature oysters under two years of age.

The presence of this class in large numbers prevents the oysters from fattening rapidly.

Another reason given is that the beds are much broken up, and that the returns are very poor for the usual amount of labor.

CONCLUSIONS.

My additional experience in the investigation and information collected during the past season has proved that a few

of the conclusions at which I arrived in 1878, and which are contained in my report of the operations of that season, are erroneous. Some of them have been already alluded to, and the allusions to the remaining ones here find their most appropriate place.

I find that my supposition that there is or was a general spatting on all the beds in any season to be, to a certain extent, incorrect. The spatting may be general, and a majority of the oysters may spawn each year, but the attachment of the young is a very different thing, and as the most precarious period in the life of the oyster is that just anterior to its attachment, a series of causes detrimental to the life of the embryo, while it is in its free swimming state may readily occur, and thus prevent such attachment.

My investigation of the past season has proved conclusively that the class of oysters termed "young growth" in my previous report were not of the brood of 1878 but of 1877 or 1876. The character of the young found in both seasons, the determination of the time of earliest attachment, and the growth and appearance of the oysters on the tiles, have led me to this conclusion. As the young do not attach before the middle of August, they could hardly reach such a size and shape by October as would prevent their recognition as of the same season's growth.

From the inspection of the oysters taken during the last season, many being found as I have stated with the generative matter unexpelled, I am of the opinion that a combination of natural causes may prevent the expulsion of both the male and female cells, and there would consequently be no impregnation during that season.

As I mention in report of 1878, many persons of experience are of that opinion, and I now concur with them in thinking that not only the attachment of young may not be general nor occur each year, but that the emission of the products of generation may also be frequently confined to partial areas, and that by a combination of circumstances there can be a total failure of impregnation on all beds of any locality.

I also find by additional experience that the young oyster is

not fit for marketable purposes until at least a year and a half or two years old, and consequently the total number of young removed, as estimated in my previous report, would be a total sacrifice.

As will be seen by the table showing the number of oysters removed, this sacrifice probably amounted in 1878 to 148,800,000 oysters.

By reference to the tables showing the success or failure of the several spatting seasons, it will be seen that there is little or no regularity of either success or failure.

We have only been able to investigate the spatting of three seasons, and it may be found by subsequent observations that two similar seasons of success, moderate success or failure will follow each other, but so far this has not been the case, and in the period of three years we have, comparatively to the other seasons, one at least of successful attachment.

I can see no reason for supposing that there is any regular recurrence of the spatting seasons, but am inclined to believe that the success or failure is due to two causes; variations of temperature and variations of density.

I have no means of ascertaining either the changes of temperature or density in the years preceding those in which I have been engaged upon this investigation, and in both seasons I arrived in the Sounds too late for the temperatures or determinations of density obtained by the party to be of practical value.

Oysters will and do live in very dissimilar temperatures, and in waters of very different densities, as is shown by their existence in the waters of North America from Nova Scotia to the Gulf, and on both Atlantic and Pacific Coasts. That the mature oyster is a hardy animal, readily adapting itself to new conditions and environment, is shown by the ease with which it is transplanted from the warm waters of the Chesapeake to the colder ones of New England; from the dense and salt waters of the ocean and Bay, to the brackish waters of the creeks and rivers or vice-versa, and from soft bottoms to hard or the reverse, but naturally this hardiness is not a quality of the immature oysters or the swimming embryos.

The influence of increased or diminished temperature upon the formation of the ova and spermatozoa must be very serious and very considerable, and, judging by analogy, it would seem probable that the formation would be more rapid during a warm spring than during a cold one.

Whether the formation has been late or early when once formed, a sudden change of density or of temperature may so affect the oyster or the generative matter that the latter would not be expelled, and only upon this hypothesis can be explained the retention of the products of generation noticed in so many oysters, and which is said to be so common, for none of the other conditions are subject to violent changes, such being peculiar to the density and temperature alone.

Prof. Brooks states that he found both ova and spermatozoa ripe and fit for fertilization about the middle of May, and as the oysters were taken from shoal water, probably one fathom deep, the shoal water oysters were probably spawning throughout June. Both Prof. Brooks and myself found the ripeness of the oysters to depend upon the depth of water from which it was taken, and this is no doubt caused by the difference of temperatures.

Prof. Brooks also states that there was a great deal of cold, rainy weather during June, and two hail storms. The rainy weather would affect the density of the water by increasing the volumes of the various creeks and rivers, and the changes of density would probably affect the production and emission of the generative matter.

It is an interesting coincidence at least, that the oysters found to be fattening with the products of generation unexpelled were either from beds in comparatively shoal water or from the shoal parts of deep water beds, and that those oysters should have been ripe and spawning during the month of June. Again, it may be that the lowness of the temperature prevented the deep water oysters from ripening as soon as usual, and the mildness of the succeeding autumn may have prevented the destruction of the ova and spermatozoa, thus rendering possible the fertilization achieved by me in October. The oysters from which I procured the ova and spermatozoa were taken from deep water.

Probably the influence of changes of environment, especially of density and temperature of the water, is most severely felt by the embryos when in their free swimming state, and, in connection with the want of success of the spatting seasons in the Sounds, it is noticed that the temperature curves show a maximum change about the time when it is supposed that the young would attach in largest numbers, or about the period when they were swimming about in the water.

It is also worthy of notice that Prof. Brooks, about this time, met with the maximum amount of success in his efforts to artificially raise the embryos.

In consideration of the foregoing, I am of the opinion that the success or failure of any spatting season is dependent upon the equability of the temperature, and that the higher the temperature during the spring months the earlier the advent of the spawning season, and that an increased temperature will also hasten the development of the spat, and of the young oysters after they have become attached.

I also infer that sudden and extensive changes of density will likewise affect the advent, duration and success of the spawning, though to a less extent.

Subsequent to the attachment of the animal, changes of the conditions surrounding it are not of so much importance, though naturally such changes will more severely affect the delicate organism of the young oyster than that of the older and more hardened adult.

During the first six months of its existence the oyster is exposed to the greatest danger from the numerous enemies which surround it. The thin, delicate shells, from one-sixteenth of an inch to one inch in diameter, are readily bored by the drills or torn off by the crabs, and the immense numbers of both of these leave no room to doubt their destructive effects. The inspection of the spat collectors in the Big Annemessex River shows that during the early months of their existence about 50 per cent. of the young oysters are destroyed, and future inspections of the hurdle will, I hope, give the rate of decrease in other periods of time.

Naturally, as the animal progresses, it becomes more hardy

and better able to resist the attacks of enemies and changes of environment, and thus we find on the unworked beds, where the oysters are practically in a natural state, that the decrease in passing from young growth to mature oysters is about 30 per cent., or about one-third of a given number perish in passing from the first to the fourth year of their existence.

Here our information ceases, but enough has been gathered to indicate the proportion which nature has assigned as necessary between the young and the mature oysters. For every 1000 of the latter there should be 1500 of the former, if the number of brood oysters necessary to maintain the fecundity of the beds is to be kept up, and though this proportion is based upon *data* which is not quite sufficient, yet, as I have said, it is all that has been afforded as yet, and may be accepted within certain limits. Certainly whatever it should be, the number of the rising generation of the animals should never be less than that of the older, or there should always be as many young as mature on any bed.

A greatly increased proportion of young to mature oysters would show either one of the two things—either the mortality in passing from youth to maturity was much greater than shown by the dredging results in the Bay, or that a very large number of mature oysters had been removed by other than natural causes.

In considering these several beds the question of food and other necessary supplies has not been considered, as it is evident that when an oyster bed is formed and exists naturally, all the conditions for its successful life are probably present, and any failure of an important supply would be followed by a speedy extinction of all the oysters on the bed. Such determinations of the quality and quantity of the food, character of bottom and water, and other matters, are only of interest and desirable for the purpose of comparing one locality with another. Such was not the purpose of this investigation, and consequently the determination of those points has been but incidental to the work.

Probably the fecundity of a bed is increased to a certain

extent by working upon it. The dredges or other implements used open the bed and spread it, thus giving more room for development, and allowing a greater amount of food to reach the animals.

The mortality is great in all thickly populated tracts and in any closely united community, and it is evident that the removal of any of the brood oysters could not be effected without destroying the fecundity of the bed, did not this very removal influence the mortality among the young so as to allow a larger number to come to maturity. But this removal of brood oysters may become so great that the most violent exertions of nature to supply others are unequal to the demand.

It must also be evident that as soon as the number of brood oysters is thus diminished, even to the slightest extent, the fecundity of the bed is impaired.

This impairment constantly increases, influencing, as it does, both old and young. As the number of the latter decrease, so will the number of the former, and as that number is again and again diminished, the number of young produced by them must constantly diminish. Thus the cause for the destruction of the fecundity of the bed, and the gradual extinction of the animals upon it, can be readily understood and as easily comprehended as the fact that the fecundity and preservation of the productive powers of a bed depends upon the number of mature, spawn-bearing oysters upon it.

It is not meant by this that none but the mature oysters are capable of reproduction, as such is not the case, oysters of even six or nine months' growth having been observed by me with ripe ova and spermatozoa in them, but the main dependence must be placed upon the adults in the community, as the spawn of the young growth is not considerable when compared with that of the other class.

Without a knowledge of the number of oysters on a bed it is impossible to say what number should be removed, and as an attainment of the knowledge of the number on the bed is almost impossible, all that can be done is to keep the proportions between the young and the mature as nearly the

same as on the natural beds, and this should be the aim and result of all laws having the protection of the beds in view.

Whether such a law is necessary or not for the locality subjected to the examinations of the last two summers I will not attempt to show.

Referring to that portion of this report relating to the fecundity of the beds in the Sounds, it is seen that in some cases the ratio of young to mature oysters is greater, and, in other cases, less than it should be, and that in a few cases the proportion seems to be within the prescribed limits. As has been shown, the decreased ratios must be the result of a want of reproduction, while the increase may be due to the removal of the mature oysters.

If we take the total number of the oysters examined in the Sounds we will have a ratio expressing the general fecundity of the beds, and this ratio between 70,866 mature oysters and 36,824 young ones is 0.5.

Assembling all the oysters counted on the beds in the Bay we would have as a ratio 1.5.

Practically, none of the mature oysters had been removed from these beds in the Bay, while large numbers had been taken from those in the Sounds. The estimates of each show approximately how many have been taken, and if by examination of them we find that the number of mature oysters taken off greatly exceeds the number of young removed, it may be assumed that the restoration of both classes to the beds would be immediately shown by a change in the proportion of young growth to mature oysters.

By the estimate of 1878 we find that 184,600,000 mature and 148,800,000 young would be removed.

But as the number of young removed would be less and less during the season, on account of the mortality among them, and as we have found that mortality to be about 50 per cent., I consider that the removal of the young during the season of 1878 and 79 probably did not exceed 74,400,000.

Therefore the total number removed was 259,000, 00, of which 71 per cent. were mature, spawn-bearing oysters.

But 65 per cent. of the oysters at present on the beds are

mature, and the addition of the 260,000,000 removed would raise this percentage to 68, which would make the ratio even smaller.

Hence, the addition of a large number of mature oysters to the total number considered in both Sounds would prove even more conclusively that the fecundity was greatly impaired.

The two beds of which we have the most exact and complete statistical records in this season are the Woman's Marsh and the Great Rock, and, by means of the record of statistics, I estimate that the following number of oysters have been removed from them:

TABLE *showing number Oysters Removed from Great Rock and Woman's Marsh.*

Name of Bed.	Removed in a Year.		Total both classes.	Percentage of Mature.
	Mature.	Young.		
Great Rock..................	10,176,000	5,640,000	15,816,000	64
Woman's Marsh..........	1,740,000	768,000	2,508,000	69

From Table II, Dredging Results in the Sounds, I find the percentage of mature oysters to the total number on the two beds mentioned is on the Great Rock 24 and on the Woman's Marsh 36. Hence we would have on the Great Rock 44 per cent. of the oysters mature and full grown, and on the Woman's Marsh 52 per cent. mature.

We find by making a similar calculation for Piney Island Bar that the percentage of mature oysters removed is 70, and that by the dredging results 20 per cent. were mature; hence, 45 per cent. represents the percentage on Piney Island Bar.

The ratios on these beds would then, were the oysters removed still present, be 1.2 on the Great Rock, 0.9 on the Woman's Marsh, and 1.2 on Piney Island Bar.

It will be seen by the above that there has been an exhaus-

tive fishing of many of the beds in the Sounds during the last four or five years—that is, exhaustive of mature brood oysters—and that consequently the large ratios of young to mature oysters is not the result of a large attachment of young, but rather of the removal of the older oysters, and, hence, the change from a large ratio to a very small one, or vice versa, may be regarded as a safe indication of the deterioration of the bed, for, as explained in the previous part of this report, the ratio will remain abnormally large until the young growth reach maturity, when it will become abnormally small, and will so remain for a few years, when it will again become very large, and this process will continue for some time, until the beds are practically unfit for dredging, as is the case in Pocomoke Sound.

Thus we see that not even the ratios alone are sure indications of the increase or decrease in the number of oysters, but that they must be considered together with other facts before we can arrive at just conclusions.

By reference to the closing paragraphs of that part of the report relating to the fecundity of the beds, it is noticed that the amount of *debris* increases on the southern Tangier beds, and that on most of the beds of the Sounds it is much greater than it was in the Bay.

An increase of this percentage, as already pointed out, is an indication of the deterioration of the beds, and is due to the destructive effects of the dredging, which not only removes many oysters, but so disturbs many others that their destruction is an almost assured fact.

To a certain extent this cannot be helped, and is a necessary incident of the fishery, but overworking the beds increases this evil as well as others, as is evident by the percentage on many of the Pocomoke beds.

Referring to the table showing the number of oysters removed in 1878, and also comparing it with the table of proportions to the square yard, the following may be noticed:

1st. In the upper part of Tangier Sound the proportions to the square yard are very large, which is probably due to the shoalness of the water and the soft bottom, which allowed

a larger number of oysters to be taken. In addition, the mature oysters are smaller than on the southern beds, as shown in the Table I, Dredging Results, thus a greater number would be taken in the dredge and the proportion increased.

2d. Though the proportions are very large, yet there is a serious decrease from that established in 1878.

By reference to the "Table showing number of oysters removed," I find that the largest number of oysters were removed from this section in both seasons, and supposing the number of dredging vessels to have been constant, instead of diminishing, one-half the number of oysters removed in 1879 would be greater by fourteen millions than the number removed in 1878, or that the fishing is proportionally increasing.

As this fishing is confined principally to the mature oysters, it can be readily understood why the proportion of these oysters to the square yard should be much decreased.

In the second section we find the proportions to be nearly the same as those outside, and that there is a gain in the rivers where there is the minimum amount of dredging, and on two beds which were worked very little in 1878–9, on account of the young growth which had attached to them.

The proportional increase of dredging, as shown by the numbers removed in each season, supposing the number of dredging vessels to have been the same, would be on this section eleven millions, and these were taken from the western beds and Piney Island Bar principally, and on those beds there is a diminished proportion.

Again, we find by reference to the tables that on the southern beds in Tangier Sound the proportion to the square yard is much smaller than that on the beds in the Bay, and this is due to probably two causes—the condition of the bed or the depth of the water, hardness of bottom and size of the oysters, and to the removal of too large a number of mature oysters.

As I have pointed out a proportion on a worked bed which falls much below that on an unworked one, must, other things being equal, be accepted as an indication of a decrease in the

productivity of the bed. That much is assumed, but on this section there appears to be an increase in the number of oysters, and that increase must be accounted for in some way.

The table showing the number of oysters removed proves that the number taken from this section to be a constantly decreasing one, for in 1878 there were taken by twice as many vessels four times as many oysters as were removed in 1879.

This may be due to two causes, and probably is due, to some extent, to both. The productivity of the beds may be impaired, or the fishery may be less earnest and exhaustive than in the past. We can only account for the increased proportions by assuming the latter to be the case, the beds having probably enforced a resting period by the material failure of the oysters.

The proportions and yield in Pocomoke Sound need no comment. Not only are the proportions below the standard and decreasing, but the yield is also decreasing, as it naturally would under such circumstances.

Naturally, as soon as any bed ceases to give an adequate return for the labor expended upon it, the dredging vessels will seek other and more profitable fields for exertion, and the desertion of any bed may be accepted as an indication of its decreased productive power, and, as has been mentioned under the head of Statistical Information, dredging vessels have, to a great extent, left the Sounds for the waters of the Bay and Potomac River.

Considering the abnormal ratios between the mature and young oysters; the increased percentage of *debris* on the beds; the smallness of the proportions to the square yard, and the decrease of those proportions on most of the beds, together with the large number of oysters, young and old, annually removed, I am of the opinion that though the fecundity of the beds in Tangier Sound is not yet destroyed, it is very much impaired, and that not only are the beds rapidly and surely deteriorating from the excessive fishery, but that their total failure, like unto that in Pocomoke Sound, is but a question of time.

So far as it is possible to make any more exact prediction

than the above, I am of the opinion that the fishery still continuing this failure will occur soonest on the beds at the entrances of the Sound on those in Sections 1 and 3, and of the two the failure of the lower beds is most likely to first occur, and of all the beds, the Woman's Marsh will be the first to give out.

As stated at the beginning of this report, the beds may be protected either directly or indirectly by either enlarging the areas for the dredgers, ensuring by artificial means the maturity of a larger proportion of the spat, or directly by limiting and restricting the fishery.

I alluded in my previous report to the manner in which this protection was afforded abroad, and suggested a manner for affording it at home, and the necessity for the adoption of some such measures seems so urgent that I earnestly hope they will shortly be undertaken.

The extension of the dredging ground can be easily attained by depositing the shells from the shell heaps about the packing houses on the bottoms contiguous to the natural beds, but such deposit should always be made in the direction of the ebb and flow of the tide, in order that the drifting spat may be carried over the newly exposed cultch. The bottom is of minor importance so long as it is of sufficient consistency to prevent the oysters from sinking into the mud. A sticky clay bottom is preferable, though the beds may be extended over sand shoals.

In searching for new beds they will probably be found about the mouths of estuaries and rivers and where there are sudden changes of bottom in the Chesapeake, depths of from two to four fathoms will be most likely to reward a search, and, where there are large beds in the creeks and rivers, it is likely that there has been a natural expansion through their mouths, and beds will probably be found off of them.

The search must be carefully conducted, or the beds which appear to be long, narrow ridges, will be missed, and the dredge should be dragged across the tide, as the beds usually extend in the direction of the current. A sudden change of depth of two or three feet, and from soft to hard bottom when on

an oyster ground, is an unfailing sign of the presence of a patch or bed.

Considering the success which has attended the investigation of Prof. Brooks, and the new light which it has thrown upon the embryological life of the oyster, I think that perhaps the most efficacious means of maintaining the productive power of the beds would be in bringing, if such be possible, the artificial impregnation of the eggs and subsequent care of the young to such a state of perfection as would be of practical utility.

Prof. Brooks is, of course, the best person to devise the method of successfully continuing his experiment, and I hope that he may be able to do so, and that they will meet with complete success, and, as pertinent to his work, which is mainly conducted by means of aquaria, I would suggest that the study of the effect of changes of temperature, so far as they affect the embryo, can be best and most easily done while engaged upon the attempt to artificially raise them. In order to arrive at certain conclusions, with regard to the effect of changes of density or of temperature, the investigation, if conducted on the natural beds, must be extended over many seasons in order to insure by a coincidence of temperatures or densities and results the elimination of other affecting conditions.

The study of the temperature seems so important that any suggestion with regard to it is of value and should claim attention.

I would also recommend that some person inspect and count at intervals the oysters on the spat collector in the Big Annemessex River. It is securely moored and buoyed with a spar buoy, and probably will remain in place.

With regard to the protection of the beds in the Sounds, I can only renew my previous recommendations of the previous year.

The deterioration of any bed will be evident by abnormal rates of young growth to mature oysters, by a small and decreasing proportion to the square yard, by large and increasing percentage of broken shells and other *debris*, and by the appearance of the oysters, as has been described.

When all these indications are present, if the dredging is not totally prohibited, it should at least be so limited as to insure the proportion of young growth remaining at least one-third greater, and great changes from this proportion are to be avoided and guarded against.

OYSTER LAWS.

OYSTERS.

PUBLIC GENERAL LAWS.

Chapter 364 *of Laws of* 1870 *as amended by Chapter* 157 *Laws of* 1872, *which repealed Chapter* 406 *Laws of* 1868 *and Chapter* 184 *Laws of* 1867, *which repealed Article* 71 *Code of Public General Laws as amended by Chapter* 333 *Laws of* 1864, *and Chapter* 181 *of the Laws of* 1865 *are repealed by Chapter* 181 *Laws of* 1874. *Sections* 3 *and* 5 *of Chapter* 181, *Laws of* 1874, *are repealed and re-enacted by Chapter* 380 *Laws of* 1876.

Laws of 1874, *Chapter* 181.

Section 1. *Be it enacted*, That no steamer shall be used in catching oysters in this State, and no other boat shall be used in catching oysters with scoop, dredge or similar instrument, without first having been licensed as hereinafter provided. **Prohibited**

Sec. 2. *Be it enacted*, That the Comptroller of the Treasury shall, upon application of any person who has been a resident of this State for twelve consecutive months next preceding such application, and to no other person, issue a license to such resident to employ such boat in catching oysters with scoop, dredge or similiar instrument, within the waters of the Chesapeake Bay, and in Eastern Bay, outside of a line drawn from the southwest corner of second Kent Point to Wade's Point; provided, that nothing herein contained shall authorize the catching of oysters with scoop, dredge or similiar instrument, on any oyster bar within one and a half miles of Talley's Point, Sandy Point, Hackett's Point, Thomas' Point, Holland Island Bar, Three Sisters, Swan Point Bar, Poplar Island, one quarter of a mile west of, and between the island and the main land, nor within half mile of Plum Point, and to buy and sell oysters in **Issue license to catch oysters.**

Time in force. this State; which license shall hold good for one year, but shall only authorize the catching of oysters between the first of October and the first of May; but it shall be lawful for the owner of any such boat licensed, whenever said owner shall sell and convey by bill of sale, for a *bona-fide* consideration, said boat unto any person who has been a resident of the State of Maryland for at least one year, to tranfer the said license to said vendee with said boat; which license, Transfer. when transferred, shall entitle said vendee with said boat to the same privileges for catching oysters in the waters of this State that the original vendor or assignor had before said assignment; provided the said vendee and assignee shall appear before the Comptroller of the Treasury and make oath before him to all the facts, matters, things and prerequisites required of said original vendor or assignor before taking out such license, upon which said license said Comptroller shall certify the fact of said vendee or assignee having taken said oath, and for which said assignee or vendee shall pay the sum of five dollars, to be paid to the State of Maryland.

Laws of 1876, *Chapter* 380.

Sec. 3. *And be it enacted*, That the owner of such boat shall make oath before the Comptroller or Make oath. his clerk, or before the Clerk of the Circuit Court of the county in which he shall reside, or if he resides in the City of Baltimore, before the Clerk of the Court of Common Pleas in said city, that he is the *bona fide* owner of such boat to be described in the license; that he has been a resident of the State for the time beforementioned; that there is no lien on said boat held by a non-resident; that the said boat is not held with an intention to violate the provions of this article, such applicant shall produce before the Comptroller or the said clerk at the time of such application Custom-House enrollment or license of such boat, and if such boat is under Custom-House tonnage, the owner shall swear as to her Make oath. tonnage, the master of such boat shall make oath before the Comptroller or clerk aforesaid, that he has been a resident of the State of Maryland for twelve months next preceding the time of taking such oath, and in all cases where such oath shall be

administered by the Clerk of the Circuit Court, or the Clerk of the Court of Common Pleas as aforesaid, such clerk so administering such oath shall certify the same fully in accordance with the provisions of this article, under seal to the Comptroller, and shall deliver such certificate to the owner or master so applying, for which certificate the said clerk shall be entitled to receive a fee of fifty cents in each case. Fee.

Laws of 1874, *Chapter* 181.

Sec. 4. *And be it enacted*, That before granting such license, the Comptroller shall receive for it, from the applicant, at the rate of three dollars per ton for every ton the boat may measure; the license shall be exhibited whenever called for by any officer of the State of Maryland. Charges.

Laws of 1876, *Chapter* 380.

Sec. 5. *And be it enacted*, That any person who shall violate any of the provisions of the preceding sections shall be deemed guilty of a misdemeanor, and on conviction thereof, in any court in this State having criminal jurisdiction, shall be sentenced to the jail of the county where the case is tried for a term not exceeding six months, or a fine not exceeding two hundred dollars, or both in the discretion of the court; provided, however, that nothing in this or the preceding sections shall be construed to apply to the sailors or crew on a vessel licensed as aforesaid; provided further, that if the captain or commander of the boat shall not be on board at the time of violating the law, the person having charge of the boat shall be held to answer the charge; and provided further, that nothing in this section shall be construed to apply to cases now pending for the violation of the Oyster Laws. Guilty of a misdemeanor. Proviso. Proviso.

Laws of 1874, *Chapter* 181.

Sec. 6. *And be it enacted*, That upon information given on oath to any judge or justice of the peace of any violation of any of the provisions of this article, he shall issue his warrant for the arrest of the offender or offenders, which warrant shall be Issue warrant for arrest.

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directed to the sheriff or any constable of the county wherein the said warrant is issued, or to any Commander or Deputy Commander of the State Fishery Force.

Resisting. Sec. 7. *And be it enacted*, That any person who shall resist any officer authorized under this act to make arrests, shall be deemed guilty of a misdemeanor, and upon indictment and conviction thereof in any court having jurisdiction shall be imprisoned in the jail of the county where the case is tried, or in the penitentiary, not more than two years, or fined not less than fifty nor more than five hundred dollars, in the discretion of the court; **Penalty.** the parties tried and acquitted under this article shall have the cost of such trial paid by the Comptroller of the State out of the fund created by this article.

Duty to arrest. Sec. 8. *And be it enacted*, That it shall be the duty of the sheriff, constable or officers of the State Fishery Force, to arrest any person found violating the provisions of this article and bring the offender before a judge of the court having criminal jurisdiction, or a justice of the peace most convenient or accessible, to be dealt with as herein provided.

Give security. Sec. 9. *And be it enacted*, That the judge or justice of the peace before whom any person may be brought, charged under oath with violating any of the provisions of this article, shall cause the party to enter into recognizance with two sureties, approved by said judge or justice of the peace, in a sum not less than five hundred dollars, for his or their appearance at the first term of the Circuit Court thereafter, and in default thereof may commit the said party to jail.

Fines. Sec. 10. *And be it enacted*, That the fines accruing under this article shall be paid by the sheriff, constable or officer of the State Fishery Force collecting the same, within ten days, to the clerk of the county or city where such fine may accrue, and such clerk shall account for the same to the Comptroller of the Treasury in his next quarterly return.

Condemned. Sec. 11. *And be it enacted*, That any boat, owned wholly or in part by any non-resident, used in catching oysters in this State with scoop, dredge or similar instrument, shall be condemned by order of any Judge of the Circuit Court nearest the place of

her capture, or, if captured in Baltimore, by order of the Judge of the City Court, and shall be sold by the sheriff of the county where condemned to the highest bidder for cash, after twenty days' notice of the time and place of sale, such notice to be published at least three times in a newspaper having the largest circulation printed in Baltimore city, or in the county where condemned; one-fourth of the proceeds of such sale shall be paid to the party making the capture, except the officers of the fishery force, and the balance shall be paid into the Treasury of the State. Proceeds of sale.

SEC. 12. *And be it enacted*, That any person who shall, without authority from the owner, catch oysters planted or bedded, shall be deemed guilty of a felony, and on conviction in the Circuit Court of the county wherein the oysters were bedded shall be sentenced to the penitentiary for a term not exceeding three years. Guilty of a felony.

SEC. 13. *And be it enacted*, That it shall be unlawful for any person to catch oysters, except for private use, or for the purpose of replanting or bedding in the waters of this State, or for sale to the citizens of the county wherein they are caught, or the county next adjoining, between the first day of May and the first day of September in each and every year. Any person violating this section shall be deemed guilty of a misdemeanor, and fined by a justice of the peace of the county wherein the offence was committed, not exceeding fifty dollars. Penalty.

SEC. 14. *And be it enacted*, That it shall be unlawful for any person to catch oysters on Sunday or at night, and any person violating this section shall be fined a sum not less than fifty nor more than five hundred dollars, by the judge or justice of the peace trying the case. Sunday or at night.

SEC. 15. *And be it enacted*, That the Comptroller of the Treasury shall have painted, in black figures on white canvas, two sets of numbers, corresponding to the license, to catch oysters with scoop, dredge or similar instrument; each figure shall be twenty-two inches in length, and of proportionate width, and the figures at least six inches apart; and he shall give to each person taking out such license two numbers thereof, one of which shall be firmly sewed Numbers. Size.

upon the starboard side and in the middle of that part of the main sail which is above the close reef, and the other number on the port side and in the middle part of the jib which is above the bonnet and reef; these numbers shall be placed in an upright position and worn at all times during the dredging season, and shall not be concealed or defaced, and no other number shall be exposed to view or used than that which is furnished by the Comptroller. Any captain who shall violate the provisions in this section shall be deemed guilty of a misdemeanor, and upon conviction in any Circuit Court of this State shall be fined not less than fifty nor more than one hundred dollars, or imprisonment in the jail of the county where the case is tried not more than six months, in the discretion of the court; provided the court or jury trying the same shall be convinced that the provisions of this section have been intentionally violated.

Placed.

Violating.

SEC. 17. *And be it enacted*, That any resident of this State desiring to use any canoe or other boat in catching or taking oysters, for sale, with rakes or tongs, in any of the waters of this State, shall first obtain, by application to the clerk of the Circuit Court for the county wherein he may reside, a license therefor, and such license shall have effect from the first day of June in the year in which it may have been obtained, to the first day of June next succeeding; provided that such license shall not authorize the use of said canoe or boat, in taking or catching oysters in any creek, cove, river, inlet, bay or sound within the limits of any county other than that wherein the license shall have been granted, and that the boundaries of counties bordering on navigable waters shall be strictly construed, so as not to permit the residents of either county to take or catch oysters beyond the middle of the dividing channel; provided that nothing in this section shall be so construed as to prevent the citizens of Calvert and St. Mary's counties from using the waters of the Patuxent River in common, or the citizens of Queen Anne and Kent from using the waters of the Chester River in common, or the citizens of Dorchester and Wicomico from using the waters of the Nanticoke in common, or the citizens of Queen Anne and Tal-

Obtain license.

Proviso.

bot from using the waters of Wye River and the mouth thereof in common.

SEC. 18. *And be it enacted*, That each and every license to take or catch oysters for sale with rakes or tongs shall state the name and residence of the person to whom the same is to be granted, the number, together with the length, to be obtained by top or over-all measurement of the canoe or boat licensed, the county in which the same is to be used, and the period at which said license will expire; and every applicant for such license shall pay to the clerk of the court where such license may be granted, and before the issuing and delivery of the same, according to the following rates, viz: for any boat measuring in length twenty feet or less, the sum of two dollars; measuring from twenty to twenty-five feet, the sum of three dollars; measuring from twenty-five to thirty feet, the sum of four dollars; and all over thirty feet, including sloops under Custom-House tonnage, the sum of five dollars each; and all oysters taken with rakes or tongs shall be culled upon the natural beds where they are taken; the amount received from tonging license to be paid by the clerk to the school commissioners for the public schools of the respective counties where such license is issued; provided the sum received from white tongers shall go to white schools, and the sum from colored tongers to the colored schools.

License to State.

Fee for.

SEC. 19. *And be it enacted*, That every applicant for license to use any canoe or other boat in taking or catching oysters with rakes or tongs shall be required to make oath or affirmation before the clerk authorized to issue the same, or some justice of the peace, on whose certificate of the taking of such oath or affirmation the clerk shall issue said license that the facts set forth in said license are strictly true; that he has been a *bona fide* resident of the county for the twelve months next preceding his application for said license that he desires and intends to use said canoe or boat only in the county in which he resides; that he will not allow the same to be used for taking oysters by non-residents of the county, and that he will comply with and obey all the laws of this State regulating the taking or catching of oysters; and every person to whom such li-

To make oath or affirmation.

cense shall have been granted shall paint the number of his canoe or boat on the outside thereof, near the gunwale, in black figures, and not less than three inches in length and of proportionate width, in a white ground; and no number other than that in the said license shall be exposed to view on said canoe or boat; and any person failing to comply with this provision before using said boat or canoe for the purpose aforesaid shall, on conviction thereof before a justice of the peace, be fined not less than five dollars nor more than ten; and any person who may refuse to pay said fine shall be committed to the county jail for the period of thirty days or until said fine be paid.

Failing to comply.

SEC. 20. *And be it enacted*, That the Comptroller of the Treasury shall cause to be printed and delivered to the clerks of the Circuit Courts of the several counties, the requisite number of such blank licenses, and take receipts for the same as for other licenses furnished; and the said clerks shall, on the first Monday of March and December in each year, return to the Comptroller a list and account of such licenses issued by them; and no licenses to take or catch oysters with rakes or tongs shall be issued to any boat or vessel which is licensed to take or catch oysters with scoop, drag, dredge or any similar instrument.

License to be printed.

SEC. 21. *And be it enacted*, That if any person shall use any canoe or boat not licensed as required by the preceding sections of this article in taking or catching oysters with rakes or tongs except for private use, he shall, upon conviction thereof before a justice of the peace for the county wherein the offence has been committed, be fined not less than twenty nor more than one hundred dollars, and in case of a refusal to pay said fine said party shall be committed to the county jail for six months or until said fine be paid.

Prohibited

SEC. 22. *And be it enacted*, That all moneys arising from the sale of licenses or from fines, penalties and forfeitures imposed under this article shall, upon warrant of the Comptroller, be paid into the Treasury and placed to the credit of the oyster fund; and the Comptroller is hereby required to state in his annual report particularly the receipts and expendi-

Monies.

tures on account of said fund, and the balance standing to the credit of the State at the time of making such report.

SEC. 23. *And be it enacted*, That the owner or owners of any land bordering on any of the navigable waters of this State, the lines of which extend into and are covered by said waters, shall have the exclusive privilege of using the same for protecting, sowing, bedding or depositing oysters or other shell-fish within the lines of their own land; and any owner or owners of land lying and bordering upon any of the waters of this State shall have power to locate and appropriate in any of the waters adjoining his, her or their lands, five acres, for the purpose of protecting, preserving, depositing, bedding or sowing oysters or other shell-fish; and that any other citizen of the State shall have power to locate and appropriate five acres in any waters in said State not located or appropriated; provided thirty days' notice in writing shall be given the owner or owners, occupant or occupants of land bordering on said water proposed to be located, that the owner or owner, occupant or occupants may have priority of claim; and if they shall fail to locate or appropriate the water mentioned in said notice within thirty days after receiving the same, then it shall be open and free to any one under the provisions of this section; provided, also, that the said location or appropriation shall be described by stakes, bushes or other proper and visible marks, metes and bounds, which description shall be reduced to writing under the oath of some competent surveyor and recorded at the expense of the party locating or appropriating the same, in the office of the Clerk of the Circuit Court in the county wherein such lands may be located; and provided, also, that such location and appropriation shall not injure, obstruct or impede the free navigation of such waters; and provided that no natural bar or bed of oysters shall be so located or appropriated, and that six months' peaceable possession of all locations of oyster grounds, under the laws of this State, shall constitute a good and sufficient title thereto; but should any one within the six months hereinbefore provided be charged with locating or appropriating any natural bed or

Exclusive privilege.

Bordering on waters.

Proviso.

Proviso.

Proviso.

Submit to court.

bar hereinbefore prohibited, the question may be at once submitted by any person interested to the Judge of the Circuit Court in the county where such question shall arise, who, after having given notice to the parties interested, proceed to hear the testimony and decide the case; and if decision be in favor of the party locating said five acres, said decision shall be recorded with the original record of said five acres, and shall in all cases be conclusive evidence of title thereto.

Exclusive right to use

SEC. 24. *And be it enacted*, That if any creek, cove or inlet, not exceeding one hundred yards at low water in breadth at its mouth make into the lands, or that if any creek, cove or inlet of greater width than one hundred yards at low water mark make into the lands, the owner or owners, or other lawful occupant or occupants, shall have the exclusive right to use such creek, cove or inlet, when the mouth of said creek, cove or inlet is one hundred yards or less in width, and when the said creek, cove or inlet is more than one hundred yards in width at its mouth at low water, the said owner or owners, or other lawful occupant or occupants, shall have exclusive right to use such creek, cove or inlet, so soon as said creek, cove or inlet, in making into said land or lands, shall become one hundred yards in width at low water, for preserving, depositing, bedding or sowing oysters, or other shell-fish, although such cove, creek or inlet may not be included in the lines of any patent.

Appropriation to build vessels.

SEC. 25. *And be it enacted*, That the sum of twenty thousand dollars is hereby appropriated from the oyster fund of this State to purchase or build six suitable sail vessels, and arm and equip the same for the service hereinafter specified, which, together with other vessels now in the service of the State, shall be styled "State Fishery Force," and the Governor, Treasurer, Comptroller, Commissioner of the Land Office, and the Clerk of the Court of Appeals, shall constitute a Board, to be styled the Commissioners of the State Fishery Force; and they are directed to purchase, arm and equip said vessels; provided, that the Board aforesaid shall, under no circumstances, exceed the above appropriation; and the Treasurer of the State, upon the requisition of

Arm and equip.

said commissioners and the warrant of the Comptroller, is hereby directed to pay the sum or sums necessary, not exceeding this and any other appropriation hereinafter mentioned, for the purposes herein specified.

SEC. 26. *And be it enacted*, That said commissioners are empowered and directed to purchase for each of the guard boats belonging to said force one suitable cannon and such other arms and ammunition as may be necessary to make them efficient. Purchase cannon.

SEC. 27. *And be it enacted*, That for the more efficient working of said Fishery Force, the waters of the State shall be divided into six districts, of which the waters of Somerset county shall constitute the first district; the waters of Wicomico and Dorchester counties the second; the waters of Talbot county the third; the waters of Kent and Queen Anne's counties the fourth; the waters of Anne Arundel county the fifth; the waters of Calvert, Charles and St. Mary's counties the sixth; each of which said districts shall be guarded by one sailing vessel, except the second and sixth districts, which shall be guarded by two sailing vessels, the vessel to be designated by the Commissioners of said Fishery Force, and shall be under the general supervision of the commander of said force. Divided into districts.

SEC. 28. *And be it enacted*, That the Board of Commissioners of the State Fishery Force shall have power to appoint a suitable person to command said force, to appoint the Deputy Commanders for their respective districts from persons of the counties whose waters comprise the different districts, who shall be commissioned by the Governor, and the said Commander and Deputy Commanders shall have power to appoint their subordinates and select their crews; and the term of office of said Commander and Deputy Commanders shall be for two years, unless sooner removed for incompetency or neglect of duty; and if any of said officers shall fail in the discharge of his duty, by reason of collusion with parties interested in violating any of the provisions of this act, he shall be guilty of a misdemeanor, and on indictment and conviction in a court of law shall be fined or imprisoned at the discretion of the court. Power to appoint. Term of office.

To remove.

SEC. 29. *And be it enacted*, That the Board of Commissioners of the State Fishery Force shall have the power to remove any officer of said force for neglect of duty or incompetency; and any officer commanding in said force shall have the power to remove any subordinate under his command and appoint a person to fill the vacancy whenever the interest of said service may, in his judgment, require him to do so.

Keep in good order.

SEC. 30. *And be it enacted*, That the said Board of Commissioners shall have power to keep the steamer and said vessels in good order; and the Treasurer of the State, upon requisition of said Commissioners and the warrant of the Comptroller, is hereby directed to pay the sum or sums necessary to carry out the provisions of this section.

Charge of the steamer.

SEC. 31. *And be it enacted*, That the Commanding Officer, who shall have charge of the steamer, may be selected from the State at large, but that the Deputy Commanders shall be selected from the districts in which they are to serve.

Constantly on duty.

Report.

SEC. 32. *And be it enacted*, That the Commanding Officer be, and he is hereby required, to keep his vessel constantly on duty when circumstances will permit, and that every locality where a violation of the law is likely to occur shall be visited as often as the duties of the force and condition of the vessel will allow, and that every three months a report shall be made to the Commissioners of the Fishery Force of all official action taken under the law, and of all moneys received for license issued to parties engaged in carrying oysters taken in this State, which, on warrant of the Comptroller, shall be paid into the Treasury.

Duty of Deputy Commanders.

Report.

SEC. 33. *And be it enacted*, That it shall be the duty of the Deputy Commanders to confine themselves ordinarily to their several districts, but it shall be competent for them to enforce any of the provisions of this act in any waters adjacent to their districts when a violation of the same shall come to their knowledge; and that they shall report quarterly to the Comptroller the amount of moneys received for licenses issued to persons engaged in carrying oysters taken in this State, and on receiving his warrant shall pay the same into the Treasury.

SEC. 34. *And be it enacted*, That the Commanding Officer and Deputy Commander of said force shall, before entering upon the discharge of their duties, take, before one of the Judges of the Circuit Court, the oath prescribed by the Constitution, and shall enter into bond to the State of Maryland in the sum of three thousand dollars, to be approved by said judges, for the faithful performance of their duties as prescribed in this act. Give bond.

SEC. 35. *And be it enacted*, That the salary of the commanding officer in charge of steamer shall be two thousand five hundred dollars per annum, and he shall have power to appoint one officer at twelve hundred dollars per annum, one engineer at twelve hundred dollars per annum, and one officer at nine hundred dollars per annum, three seamen at thirty dollars per month, two seamen at twenty-five dollars per month, one fireman at thirty-five dollars per month, one fireman at thirty dollars per month, one fireman at twenty-five dollars per month, one steward at twenty-five dollars per month, one cook at twenty-five dollars per month; and each Deputy Commander shall receive a salary of twelve hundred dollars per annum, and shall have power to appoint one officer at a salary of eight hundred dollars per annum, and three seamen at a salary of forty dollars per month, each to be selected from the district in which they are to serve. Salaries.

SEC. 36. *And be it enacted*, That the officers and crew of the steamer aforesaid shall each receive one ration per day of the quality and quantity such as is allowed by law to the officers and crew of the Revenue Marine of the United States, but no rations shall be allowed to officers or crews of the sailing vessels. Rations.

SEC. 37. *And be it enacted*, That the officers and crew aforesaid shall be paid monthly by the Treasurer, upon warrant of the Comptroller, and the certificate of commanding officers that their duties have been performed as required by law; and the Board of Commissioners of the State Fishery Force shall have power to appoint some suitable person to perform the duty of clerk to said commissioners and allow such compensation to said clerk as in their judgment may be proper; provided the amount so paid does not exceed five hundred dollars per annum. Shall be paid

Not to affect.

SEC. 38. *And be it enacted*, That nothing contained in this act shall affect any suits, actions, presentments or indictments now pending before any tribunal in this State which have been instituted under the provisions of the article hereby repealed.

Not to apply.

SEC. 39. *And be it enacted*, That nothing in this act shall be construed so as to apply to Worcester county.

Construe.

SEC. 40. *And be it enacted*, That nothing in this act shall be construed to prohibit vessels from seeking harbors in any waters of this State.

Laws of 1878, *Chapter* 471.

When unlawful to catch oysters.

SECTION 1. *Be it enacted by the General Assembly of Maryland*, That it shall not be lawful for any person or persons to take or catch oysters for any purpose, in any manner, or with any instrument whatever, in the waters of the Patuxent river within the boundaries of Calvert county, between Point Patience and Sheridan's Point, in Calvert county, and between Town Point and Long Point, in Saint Mary's county, from the first day of May to the first day of October in each year after the passage of this act; provided, however, that this act shall not be construed to prohibit the citizens of Calvert county or Saint Mary's county from taking from the waters thereof oysters for private use, or for the purpose of replanting or bedding in the waters of said counties, or for sale to the citizens of the county wherein they are caught.

Issue warrant for arrest.

SEC. 2. *And be it enacted*, That upon information given upon oath to any justice of the peace in and for the counties aforesaid of any violation of the provisions of this act, the said justice of the peace shall issue his warrant for the arrest of the offender or offenders, and the seizure of the canoe or boat in his or their possession, or used in the commission of the offence, together with the tackle, instruments and all thinge on board at the time of the commission of the offence, which warrant shall be directed to the sheriff or any constable of the county, and shall be returnable in five days from the issuing thereof.

SEC. 3. *And be it enacted*, That the justice of the peace before whom such warrant is returnable shall,

upon the return thereof, docket a case in the name of the State against the person or persons arrested and the property seized by virtue of said warrant; and if upon trial the said person or persons are guilty of violating the first section of this act, he shall render judgment, either imposing a fine upon each person so guilty of not less than twenty-five dollars or more than one hundred dollars, or condemning the canoe or boat in possession of the offender or offenders, or used in the commission of the offence, together with all the tackle, instruments and all things on board at the time of the commission of the offence, or used or employed in the commission thereof, to be sold at public auction for cash by the sheriff or constable seizing the same, after ten days' notice given publicly of the time, place, manner and terms of sale, set up at the court house door of said county; the proceeds of said sale, after paying the costs of proceedings had, shall go one-fourth to the sheriff or constable, one-fourth to the informer, and the remaining half to the County Commissioners for public road purposes.

Docket case in name of State.

Fine—how disposed of

SEC. 4. *And be it enacted*, That any party or parties against whom a justice of the peace shall have rendered judgment under the provisions of this act may, at any time within ten days from the rendition thereof, appeal from such judgment to the Circuit Court of Calvert county or Saint Mary's county; but no execution or sale shall be stayed unless the party appealing shall give bond to the State of Maryland in double the amount of the fine imposed or value of the property condemned, with surety to be approved by said justice, and with condition to prosecute such appeal with effect, and to pay the parties entitled to the same the value of the property condemned or amount of fine imposed, and all costs in case such judgment shall be affirmed; and in all cases of appeal each party shall be entitled to trial by jury.

Right of appeal.

CRAIGHILL CHANNEL.

Laws of 1870, *Chapter* 405.

SECTION 1. *Be it enacted by the General Assembly of Maryland*, That it shall not be lawful for any

Not to catch oysters.

person or persons to rake, drag or dredge for oysters within five hundred yards of either edge of the new channel at the mouth of Patapsco river, known as the "Craighill Channel," extending from the Seven Foot Knoll to the mouth of Magothy river.

Forfeit for violation.

Fine.

SEC. 2. *And be it enacted*, That any person or persons violating the first section of this act shal forfeit his boat or vessel, and it shall be lawful for any justice of the peace of the county or city in which such person or persons shall be arrested, to try such person or persons, and on conviction to condemn said boat or vessel and sell the same on five days' notice, and fine the said offender or offenders a sum not less than five nor more than twenty-five dollars for each and every offence, and the said justice of the peace shall pay over one-half of said fines and forfeitures to the informer, and the other half to the School Board of said county or city.

PUBLIC LOCAL LAWS.

BALTIMORE CITY.

Section 494 *of Article* 4 *of the Code of Public Local Laws is amended by Chapter* 368 *of Laws of* 1864.

Laws of 1864, *Chapter* 368.

SECTION 1. All oysters carried to the city of Baltimore for sale shall be sold by the sealed half bushel, or sealed bushel and half measure, and each and every person offending against the provisions of this section shall be subject to a fine of fifty dollars for each and every offence, to be recovered before a justice of the peace of the city of Baltimore, by action of debt in the name of the State of Maryland, one-half to the informer and the other half to the use of the State. Fine.

Chapter 193 *of Laws of* 1872 *is repealed and re-enacted by Chapter* 221 *of Laws of* 1874.

Laws of 1874, *Chapter* 221.

SECTION 1. All oysters in the shell disposed of in the city of Baltimore, or in the port of Crisfield, or at any oyster packing establishment in this State, shall be measured in an iron circular tub, of any capacity from one-half bushel to three bushels, as may be agreed upon between the buyer and seller; said measure shall contain in quantity for each bushel thereof, according to the following dimension, that is to say: sixteen and one-half inches across from inside to inside at the bottom, eighteen inches across from inside to inside at the top, and twenty-one inches diagonal from the inside chime to the top, and the same shall be even or struck measure; all oysters in the shell sold in the city of Baltimore shall be measured by a licensed measurer. Any

Oysters measured.

Dimensions of measure.

person may obtain a license therefor from the Clerk of the Court of Common Pleas, by paying therefor ten dollars and taking an oath before said clerk for the faithful performance of his duty; said license shall hold good for one year. A measurer shall receive for his services one-half cent per bushel, to be paid equally by the buyer and seller. Any person or persons violating the provisions of this act shall be deemed guilty of a misdemeanor, and on conviction, shall be fined not less than twenty nor more than fifty dollars for each offence, and imprisoned until the fine and costs are paid.

License for.

Violating.

SEC. 2. The measure provided for in section one of this act shall be inspected and stamped by the proper officer in the city of Baltimore, and it shall be unlawful to use any other measure. Any person violating this section shall be deemed guilty of a misdemeanor, and upon conviction shall be fined not more than fifty dollars for each offence and imprisoned until fine and costs are paid; provided, however, that nothing in this act shall be construed to apply to oysters shipped in the barrel on any steamboat which are to be sold in the barrel.

Measure to be inspected.

DORCHESTER COUNTY.

Chapter 81 *of Laws of* 1872, *which repealed and re-enacted with amendments Chapter* 129 *Laws of* 1870, *as repealed and re-enacted by Chapter* 214 *Laws of* 1874, *which is repealed and re-enacted by Chapter* 325 *Laws of* 1878.

Laws of 1878, *Chapter* 325.

SECTION 1. *Be it enacted by the General Assembly of Maryland*, That the act passed at the January session, eighteen hundred and seventy-four, relating to catching oysters with scoops or light dredge in the waters of Dorchester county, be and the same is thereby repealed and re-enacted to read as follows:

Repealed and re-enacted.

SEC. 2. *And be it enacted*, That it shall be lawful for citizens of Dorchester County to catch oysters with scoop or light dredge in boats not exceeding ten tons burthen, according to rules of Custom House measurement, in Honga river, Hooper's straits, Par

Where oysters may be caught.

bay, and that part of Fishing bay which lies to the southward and westward of a straight line drawn from the middle of the mouth of Tedious creek to Clay Island Light House, and in all the waters to the southward and eastward of Clay island, in Dorchester county, and adjoining the Wicomico lines up to Sandy island; provided that no boat or boats licensed under the provisions of this act shall work within two hundred yards of the shore; and the Board of County Commissioners for Dorchester county shall purchase two buoys of proper size and have them properly anchored on said straight line between Tedious creek and Clay Island Light House, and the captain of the oyster sloop of the second district shall place them in position. Place proper buoys.

SEC. 3. *And be it enacted*, That the residents of said county be allowed to catch oysters with scoop or light dredge in the waters above named, by obtaining from the Clerk of the Circuit Court for said county, a license, which shall have effect from the first of September to the first of the next ensuing September of each year, and provided that said license shall not authorize the taking of oysters, as aforesaid, between the first day of May and the fifteenth day of September. Must obtain license.

SEC. 4. *And be it enacted*, That every license to catch oysters with scoop or light dredge shall state the name and residence of the person to whom the same is to be granted, the number beginning with two hundred, together with the full or true tonnage of said boat or vessel, according to the rule of Custom House measurement, and every owner of a boat or vessel shall pay two dollars per ton for every ton said boat or vessel shall measure according to Custom House rule of measurement. State name and residence.

SEC. 5. *And be it enacted*, That the Board of School Commissioners of Dorchester county shall appoint a competent person to measure all boats and vessels under ten tons licensed under this act, according to the rules of measurement now in use by the Custom House of the United States. Rules of measurement.

SEC. 6. *And be it enacted*, That the measurer appointed under this act shall enter into bonds to Dorchester county, in the sum of five hundred dollars, for the faithful performance of his duty, and shall Compensation.

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be allowed as a fee for the measurement of each boat the sum of fifty cents per ton for every ton said boat or vessel may measure.

Make oath or affirmation.

SEC. 7. *And be it enacted*, That any applicant for a license under the provisions of this act shall be required to make oath or affirmation before the Clerk of the Circuit Court of said county, or before any justice of the peace of said county, upon whose certificate of the taking of such oath or affirmation the said clerk may issue said license as hereinbefore provided; the applicants shall set forth in said oaths or affirmations, before obtaining said license, that he has been a *bona fide* resident of said county for the twelve months next preceding his application for said license, and that he intends to use said boat or vessel only in said county, and that he will comply with and obey all laws of this State regulating the catching of oysters; and any person to whom said license shall have been granted shall paint the number of his boat on each beam, near the gun-wales, or a white field with black letters, seven inches in length, and any person refusing to comply with this provision shall, on conviction before a justice of the peace for said county, be fined not less than five and not more than twenty dollars and costs, said fine to be paid into the treasury of the public school fund for said county.

To comply with laws.

SEC. 8. *And be it enacted*, That any person who shall use any boat, canoe or other vessel without having been licensed as hereintofore provided, shall, upon conviction thereof before a justice of the peace, be fined not less than twenty-five or more than one hundred dollars, or forfeit the boat, canoe or vessel so offending, in the discretion of the justice trying [trying] the same; provided that an appeal to the Circuit Court, with bond and approved security, shall be granted at any time within twenty days from the rendering of such decision by said justice of the peace.

Right of appeal.

SEC. 9. *And be it enacted*, That all moneys arising from fines or forfeitures under this act, after the deduction of all costs, shall be paid by the offender directly to the sheriff, or a deputy sheriff of the county, if present, if not, to the justice, and by them paid into and credited to the public school fund of

Fines to be paid to sheriff.

said county, and the said offender shall stand committed until the fine and costs are paid, or appeal is taken as hereinbefore provided; and all justices of the peace before whom fines are imposed under this act shall report the amount of the same to the treasurer of the school commissioners within thirty days thereafter, under penalty of fine of double the amount thereof, in case of neglect or refusal, upon indictment and conviction thereof in the Circuit Court for said county. Report amount.

SEC. 10. *And be it enacted*, That any master or owner of a canoe, boat or vessel, or non-resident, who shall take oysters with scoops, scrapers or light dredge, or other instruments, in the waters of said county now reserved for tonging, shall be subject to the same penalty prescribed in section eight and nine of this act. Penalty for violation.

SEC. 11. *And be it enacted*, That the clerk of the Circuit Court for said county shall be allowed as a fee for each license issued under this act the sum of fifty cents, and shall be required to pay the residue of the license money into the public school fund of said county, quarterly, and to keep a correct statement of said fund on file in his office. Fee for license.

SEC. 12. *And be it enacted*, That all boats licensed under the provision of this act, shall be privileged to take or catch oysters in the waters of the Great Choptank River where it is now lawful for boats to take or catch them with scoops or light dredge, without additional cost of license. No additional cost of license.

Laws of 1868, *Chapter* 228.

SECTION 1. *Be it enacted by the General Assembly of Maryland*, That it shall not be lawful for any person or persons to take or catch oysters with rakes, drags or dredge within the waters of the Honga river, in Dorchester county, nor in the Nanticoke river at or above Roaring Point, in Dorchester and Wicomico counties, in quantities over five bushels in any one day during the three summer months, June, July and August, by any canoe, boat or vessel. Not to drag or dredge for oysters

SEC. 2. *And be it enacted*, That any person or persons violating the first section of this act shall forfeit his canoe, boat or vessel; and it shall be law- Forfeit.

ful for any justice of the peace of the county of Dorchester or of Wicomico county to try such person or persons, and if found guilty of a violation of the first section of this act may condemn said canoe, boat and vessel, and sell the same on five days' notice, and fine the said offender or offenders a sum not less than five nor more than twenty dollars for each and every offence, and said justice of the peace shall pay over said fines and forfeitures to the School Board of said counties to be used in building and repairing school houses in the county where the justice of the peace resides.

Section 1 *of Chapter* 437 *of* 1874 *is repealed and re-enacted by Chapter* 405 *Laws of* 1876, *which is repealed and re-enacted with amendments by Chapter* 359 *Laws of* 1878.

Laws of 1874, *Chapter* 437.

Make oath.

SECTION 2. *And be it enacted*, That the owner of such boat shall make oath before the said clerk that he is the *bona fide* owner of such boat, which boat shall be described in the license, that he has been a resident of the county in which his application is made for twelve months; that there is no lien on said boat held by a non-resident, and that such boat is not held with an intention to violate the provisions of this law; and shall also make oath as to the tonnage of such boat; and the master and crew of such boat shall each make oath before said clerk that he has been a resident of the said county for twelve months next preceding the time of taking such oath.

Constituted Officers.

SEC. 3. *And be it enacted*, That all owners and masters of boats licensed under this article are hereby constituted officers of the county, and are hereby clothed with authority to arrest any and all violators of this article, and to take such violators before any judge or justice of the peace, to be dealt with as hereinafter provided; and for the purpose of making such arrests are hereby clothed with the power to summon the *posse comitatus* to their aid.

SEC. 4. *And be it enacted*, That upon information, given upon oath, to any justice of the peace of said counties of any violations of this act, the said justice

of the peace shall issue his warrant for the arrest of the offender or offenders, and the seizure of the boat and furniture on board, which warrant shall be directed to the sheriff or any constable of the county, or any officer created by this act, or to any officer of the State Fishery Force. Issue his warrant.

SEC. 5. *And be it enacted*, That all money arising from fines and forfeitures imposed by this act shall be paid to the sheriff or any constable of the county, and by him paid, one-half to the informer and person making the arrest, and the other half monthly to the county commissioners of the county; and the said county commissioners are hereby authorized to use such money, together with the sums received for license under this act, which sums the clerk is hereby directed to pay over monthly to the said county commissioners, after deducting therefrom his usual fees for issuing license in providing proper police officers for the proper enforcement of the provisions of this act; and in case of a surplus remaining over at the end of each fiscal year of the county it shall be placed to the credit of the school fund of said county. Shall be paid to the sheriff. Pay over monthly.

SEC 6. *And be it enacted*, That the said county commissioners of each county shall, before the first day of August in each year, furnish the clerk of each of their respective counties two hundred blank certificates of license, to be filled up by said clerks with the description of the boat and crew, and number of the boat, and name of person obtaining the license; and all boats licensed under this act shall have the number of said license painted on each side of the bow of such boat, in black figures, to be on a white ground of a size not less than five inches in length and also painted upon two pieces of canvas, one of which shall be sewed upon the starboard side of the jib, and the other upon the port side of the mainsail of such boat, and such figures shall not be less than seven inches in length; and the licenses for Talbot county shall be numbered from one upwards; and those for Dorchester county from two hundred upwards. Furnish blank certificates. Paint numbers.

SEC 7. *And be it enacted*, That any person who shall violate any of the provisions of the preceding sections shall be deemed guilty of a misdemeanor, Violation.

and, upon conviction thereof by any judge of the circuit court, or a justice of the peace for either of said counties before whom such case may be tried, shall be fined not less than twenty-five nor more than one hundred dollars, or forfeit the boat or vessel in possession of the party offending, together with the papers, furniture and tackle on board, in the discretion of the judge or justice hearing such case.

Penalty for violating.

SEC. 8. *And be it enacted*, That nothing in this act shall be construed to prevent the residents of Dorchester county, who have been licensed to catch oysters in the waters of Fishing Bay and Hongo River with scrapers, from enjoying the privileges of this act.

Be construed.

SEC. 9. *And be it enacted*, That the Board of County Commissioners of Talbot county shall appoint a competent person to measure all canoes or other boats authorized to catch oysters under this act in the waters of Talbot county, according to the rule now in use by the custom-house of the United States; said measurer to receive as a fee for his services fifty cents per ton for each ton the boat may measure; to enter into bond to the county aforesaid, in the sum of five hundred dollars, for the faithful performance of his duty, and to hold his office during the term of said commissioners.

Appoint a competent.

Give bond.

Laws of 1876, *Chapter* 405.

SECTION 10. *And be it enacted*, That any resident of said counties desiring to use any canoe or other boat in catching or taking oysters for sale with rakes or tongs in the said Choptank river shall first obtain, by application to the Clerks of the Circuit Courts of said counties, a license therefor, and such license shall have effect from the first day of June in the year in which it may have been obtained, to the first day of June succeeding, and shall authorize the use of said canoe or boat in taking or catching oysters on either side of the dividing channel of said river, for sale to any person; provided that nothing herein contained shall be so construed as to conflict with the rights of owners or occupants of lands bordering on said river as are secured and protected under existing laws.

Obtain license.

Proviso.

SEC. 11. *And be it enacted*, That this act shall have full force and effect from the first day of June, eighteen hundred and seventy-six, until the first day of June, eighteen hundred and eighty. Full force and effect.

Laws of 1876, *Chapter* 396.

SECTION 1. *Be it enacted by the General Assembly of Maryland*, That it shall be unlawful to take or catch oysters with tongs, rakes or any other instrument in the waters of Dorchester county in the months of June, July and August of each and every year; provided that five bushels per week may be taken for the use of each family. Unlawful. Proviso.

SEC. 2. *And be it further enacted*, That any person or persons violating the provisions of the preceding section shall, upon conviction thereof, forfeit and pay the sum of ten dollars and the forfeiture of boat or canoe used in said violation, and for every subsequent violation a fine of twenty dollars shall be imposed and the forfeiture of boat and canoe employed in the violation of this act, the same to be recovered before any justice of the peace within said county, one-half of all fines, including the money arising from the sale or sales of boats or canoes forfeited shall be awarded to the informer or informers, and the remainder to be paid into the free school treasury of Dorchester county, for the use of said schools; provided nothing in the two preceding sections of this act, or any part thereof, shall apply to catching oysters in either the Great or Little Choptank rivers or their tributaries in Dorchester county. Penalty for violating.

SEC. 3. *And be it enacted*, That all boats or canoes captured and condemned under the provisions of the preceding section shall be sold at public auction to the highest bidder for cash, after giving ten days' notice of the time and place of sale in such manner as may be directed by the justice of the peace making the condemnation. Sold at public auction.

Laws of 1878, *Chapter* 359.

SECTION 1. *Be it enacted by the General Assembly of Maryland*, That chapter four hundred and thirty-seven of the Acts of the General Assembly of Maryland, passed at January session, eighteen hundred Repealed and re-enacted.

and seventy-four, and chapter four hundred and five of the acts passed at January session, eighteen hundred and seventy-six, relating to the catching of oysters with scoop, scrape or dredge in the waters of Dorchester and Talbot counties, be and the same are hereby repealed and re-enacted with amendments, as follows:

Issue license.

SEC. 2. *And be it enacted*, That the Clerk of the Circuit Court of Talbot or Dorchester county shall, upon the application of any person who has been a resident of such county for twelve months next preceding such application, and to no other person, issue a license to such resident to employ any boat of a capacity of ten tons or under, such capacity to be ascertained by Custom House measurement, in taking or catching oysters with dredge, scoop or scrape in the waters of the Choptank river in said counties, for sale to any person between the fifteenth day of September in each year and the first day of June next following; provided that nothing in this act shall authorize the taking of oysters with dredge, scoop or scrape, above a straight line drawn from Oyster Shell Point on the Dorchester shore to the Talbot shore, immediately opposite, or in any tributaries of said river above or below said Oyster Shell Point; and provided further, that the applicant shall pay to said clerk, before the issuing of said license, the sum of two dollars per ton, according to the capacity of the vessel to be licensed, which said license shall be good for twelve months from the day of its issue; and until such license is obtained it shall be unlawful to use or employ any vessel in taking or catching oysters as hereinbefore described; provided that the waters of Talbot county lying between Black Walnut Point and a line drawn from Tilghman's Point to the southwest point of Parson's Island, except the waters between Poplar Island and the main land lying within a line drawn from a point of land on the north side of Ferry cove, known as Lowe's Point, to the northern extremity of Poplar Island on the north to a line from the northwest extremity of Tilghman's Island to the southern extremity of south bar of Poplar Island on the south, which are hereby reserved for the use of tong men, shall be opened to the citizens of Talbot county,

When unlawful.

licensed under this act, between the fifteenth day of September in each year, and the first day of May next following, but it shall be unlawful to take oysters with scoop or dredge in any other waters of Talbot county; provided, also, that the waters of Choptank river lying north of a straight line running from Benoni's Point to Clora's Point are hereby reserved for tong men, and it shall not be lawful to catch oysters with scoop, scrape or similar instrument to the northward of said line. What is reserved.

Sec. 3. *And be it enacted*, That the owner of such boat shall make oath before the said clerk that he is the *bona fide* owner of such boat, which boat shall be described in the license; that he has been a resident of the county in which his application is made for twelve months; that there is no lien on said boat held by a non-resident, and that such boat is not held with an intention to violate the provisions of this law; and shall also make oath as to the tonnage of such boat; and the master and crew of such boat shall each make oath before said clerk that he has been a resident of the said county for twelve months next preceding the time of taking such oath. Term of residence.

Sec. 4. *And be it enacted*, That all owners and masters of boats licensed under this article are hereby constituted officers of the county, and are hereby clothed with authority to arrest any and all violators of this article, and to take such violators before any judge or justice of the peace, to be dealt with as hereinafter provided; and for the purpose of making such arrests are hereby clothed with the power to summon a *posse comitatus* to their aid. Summon *posse comitatus*.

Sec. 5. *And be it enacted*, That upon information given upon oath to any justice of the peace of said counties of any violation of this act, the said justice of the peace shall issue his warrant for the arrest of the offender or offenders, and the seizure of the boat and furniture on board, which warrant shall be directed to the sheriff or any constable of the county, or any officer created by this act, or to any officer of the State Fishery Force. Arrest offenders.

Sec. 6. *And be it enacted*, That all money arising from fines and forfeitures imposed by this act shall be paid to the sheriff or any constable of the county, and by him paid one-half to the informer and per- Fine—how disposed of

son making the arrest and the other half monthly to the County Commissioners of the county; and the said County Commissioners are hereby authorized to use such money, together with the sums received for license under this act, which sums the clerk is hereby directed to pay over monthly to the said County Commissioners, after deducting therefrom his usual fees for issuing license, in providing proper police officers for the proper enforcement of the provisions of this act; and, in case of a surplus remaining over at the end of each fiscal year of the county, it shall be placed to the credit of the school fund of said county.

Furnish blank certificates.

SEC. 7. *And be it enacted*, That the said County Commissioners of each county shall, before the first day of August in each year, furnish the clerk of each of their respective counties two hundred blank certificates of license, to be filled up by said clerks with the description of the boat and crew and number of the boat, and name of the person obtaining the license; and all boats licensed under this act shall have the number of said license painted on each side of the bow of such boat, in black figures, to be on a white ground of a size not less than five inches in length; and also painted upon two pieces of canvas, one of which shall be sewed upon the starboard side of the jib and the other upon the port side of the mainsail of such boat, and such figures shall not be less than seven inches in length; and the licenses for Talbot county shall be numbered from one upwards; and those for Dorchester county from two hundred upwards.

Length of figures.

Fine for violation.

SEC. 8. *And be it enacted*, That any person who shall violate any of the provisions of the preceding sections shall be deemed guilty of a misdemeanor, and, upon conviction thereof by any judge of the Circuit Court, or a justice of the peace for either of said counties before whom such case may be tried, shall be fined not less than twenty-five nor more than one hundred dollars, or forfeit the boat or vessel in possession of the party offending, together with the papers, furniture and tackle on board, in the discretion of the judge or justice hearing such case.

How construed.

SEC. 9. *And be it enacted*, That nothing in this act shall be construed to prevent the residents of

Dorchester county, who have been licensed to catch oysters in the waters of Fishing bay and Hungary river with scrapers, from enjoying the privileges of this act.

SEC. 10. *And be it enacted*, That the Board of County Commissioners of Talbot County shall appoint a competent person to measure all canoes or other boats authorized to catch oysters under this act in the waters of Talbot county, according to the rule now in use by the Custom House of the United States, said measurer to receive as a fee for his services fifty cents per ton for each ton the boat may measure, to enter into bond to the county aforesaid, in the sum of five hundred dollars for the faithful performance of his duty, and to hold his office during the term of said commissioners. Appoint measurer.

SEC. 11. *And be it enacted*, That any resident of said counties desiring to use any canoe or other boat in catching or taking oysters for sale with rakes or tongs in the said Choptank river, shall first obtain, by application to the Clerks of the Circuit Courts of said counties, a license therefor, and such license shall have effect from the first day of June in the year in which it may have been obtained to the first day of June succeeding, and shall authorize the use of said canoe or boat in taking or catching oysters on either side of the dividing channel of said river for sale to any person; provided that nothing herein contained shall be so construed as to conflict with the rights of owners or occupants of lands bordering on said river as are secured and protected under existing laws. Must obtain license

CALVERT COUNTY.

Laws of 1870, *Chapter* 188.

SECTION 1. *Be it enacted by the General Assembly of Maryland*, That it shall be unlawful for any person or persons to catch oysters for sale in the waters of Saint Leonard's Creek, Island Creek and Battle Creek, in Calvert county, except persons who have imbedded or planted, or who may hereafter imbed or plant oysters in said waters. Not to catch oysters.

SEC. 2. *And be it enacted*, That on information given under oath of any violation of this act to any

Justice of the peace to issue.

justice of the peace of Calvert county, he shall forthwith issue his warrant directed to the sheriff, or any constable or military officer, requiring either of them to whom it may be directed to summon the *posse comitatus*, if necessary, and proceed forthwith to arrest the party or parties alleged to have been engaged in violating this law, and to seize and take possession of any canoe, boat or vessel, together with all their tackle and apparel, and any article on said boat at the time belonging to said party or parties and used by them in violating the law.

Take possession.

SEC. 3. *And be it enacted*, That the sheriff, constable, or military officer who has made the arrest, shall forthwith bring the offender or offenders before some justice of the peace of the county for a hearing, and said justice of the peace shall either give the case an immediate hearing, or at the instance of the party shall appoint some early day, within the next five days thereafter, to hear the case, the party charged giving such good and sufficient bail as said justice shall require for his attendance; and on conviction of the offender or offenders the said justice shall decree a forfeiture of the canoe, boat or vessel, together with all the tackle and apparel, and order the same to be sold by the officer making the arrest, who shall sell the same, on five days' notice, to the highest bidder, subject to an appeal to the Circuit Court for Calvert county, and after the payment of all the expense attending the arrest and prosecution of the suit he shall retain one-fourth of the balance himself, distributing one-fourth among the parties assisting in making the arrest, and pay over the remaining one-half to the School Fund of the county, to be used in the repair of old and the erection of new public school houses.

Hearing of offenders.

Forfeiture.

Shall sell.

Laws of 1878, *Chapter* 163.

SECTION 1. *Be it enacted by the General Assembly of Maryland*, That it shall not be lawful for any person to take or catch oysters for sale with rakes, tongs or any other instrument whatever in the waters of Mill Creek, Back Creek or Saint John's Creek, in Calvert county, for the period of three years from the passage of this act, except from land in said waters located and appropriated, or which may be

Not lawful

hereafter located and appropriated by virtue of any act or acts of the General Assembly of Maryland, authorizing the location and appropriation thereof for the purpose of protecting, preserving, depositing, bedding or sowing oysters, and any person violating the provisions of this law shall be deemed guilty of a misdemeanor, and shall upon conviction thereof before a justice of the peace of said county be fined a sum not less than twenty nor more than fifty dollars. Penalty.

SEC. 2. *And be it enacted*, That for the purposes of this act a line drawn from the steamboat wharf on Solomon's Island, and running in a northeasterly direction to Township Point on Rousby Hall farm, shall be the dividing line between the mouth of Mill Creek and the Patuxent River. A line drawn from.

KENT COUNTY.

Section 1, *Chapter* 359, *Laws of* 1872, *is modified by Chapter* 381, *Laws of* 1876. *See Queen Anne's County.*

Laws of 1872, *Chapter* 359.

SECTION 1. *Be it enacted by the General Assembly of Maryland*, That any resident of either Queen Anne's or Kent county owning or having in his possession any canoe or other boat under Custom House tonnage, and desiring to use said boat or canoe in taking or catching oysters for sale with rakes or tongs, in any of the waters of the aforesaid counties, shall first obtain, by application to the Clerk of the Circuit Court for that county wherein he may reside, a license, such as is now prescribed by the General Law, and which said license shall give him a right to take or catch oysters in the waters of either Queen Anne's or Kent county; and such license shall have effect from the first day of October in the year in which it shall have been obtained to the first day of October next succeeding, subject to the provisions of the General Law as to the time in which oysters shall be caught or taken with tongs; *provided*, that such license shall not authorize the use of said canoe or boat in taking or catching oysters in any creek, river, cove, inlet, bay or sound within the limits of any county other than Queen

Tongsmen allowed to catch oysters.

By obtaining a license.

Proviso.

Anne's and Kent; and that the boundaries of the counties bordering on navigable water shall be strictly construed so as not to permit the residents of either of these counties to take or catch oysters beyond the channel of the creeks or rivers lying between these and other contiguous counties; and *provided further*, that this act shall not authorize the taking or catching of oysters from grounds already located or appropriated for the purpose of preserving, depositing or bedding the same in the waters of said counties, under the provisions of the General Laws.

QUEEN ANNE'S COUNTY.

Laws of 1876, *Chapter* 381.

Boundary line.

SECTION 1. *Be it enacted by the General Assembly of Maryland*, That the following lines, to wit: from the south point of Wye Island to the southeast point of Bennett's Point, thence to the south point of Parson's Island, be and the same are hereby established as a boundary for the protection of the oyster grounds in that branch of Wye river known as "Back Wye," and the oyster grounds lying on the land or Queen Anne's side of that part of said boundary extending from the south east point of Bennett's Point to the south point of Parson's Island.

Not lawful.

SEC. 2. *And be it enacted*, That it shall not be lawful for any non-resident of Queen Anne's county to catch by the means of tongs, or by any other means, or in any manner to molest oysters, the protection of which is contemplated by this act, to wit: oysters within or on the land or Queen Anne's side of the boundary herein above specified.

Opened in common.

SEC. 3. *And be it enacted*, That the dividing waters of Wye river, and the waters of St. Michael's river lying west of the boundary line described in section one of this act, and the waters around Herring Island, are hereby opened to the citizens of Queen Anne's and Talbot counties in common, for the purpose of taking or catching oysters with rakes or tongs.

Be lawful.

SEC. 4. *And be it enacted*, That it shall be unlawful for any person to take or catch oysters with scoop, scrape or any similar instrument in the waters

of Queen Anne's county lying west of Kent Island, between Kent Point and Cove Point, within four hundred yards of the shore.

SEC. 5. *And be it enacted*, That any person who shall violate this act, upon conviction thereof before a justice of the peace for Queen Anne's county, shall be fined not less than twenty nor more than one hundred dollars, and upon the refusal and failure to pay said fine said party shall be committed to the county jail until said fine shall be paid; provided that the said confinement in jail shall not exceed six months. Penalty.

SEC. 6. *And be it enacted*, That this act shall take effect from the date of its passage, and all acts or parts of acts inconsistent with this act be and the same are hereby repealed. In force. Repealed.

Also see Kent County.

SOMERSET COUNTY.

Code of Public Local Laws, Article 19.

SECTION 91. It shall not be lawful for any person to take oysters within the waters of Somerset county for the purpose of manuring land.

SEC. 92. It shall not be lawful for any person in said county, or any person whatsoever, to purchase any oysters for the purpose of manuring land from any person whom they know to have caught the same within the waters of said county.

SEC. 93. Any person violating the provisions of either of the last two preceding sections shall be liable to a penalty of not less than ten nor more than twenty dollars, to be imposed, upon conviction thereof before a justice of the peace of the county, one-half to the informer and the other half for the use of the school fund of said county.

Sections 94, 95 *and* 97 *of Article* 19 *Code of Public Local Laws are amended and re-enacted by Chapter* 129 *Laws of* 1867.

Laws of 1867, *Chapter* 129.

SECTION 94. That it shall be lawful for the citizens of said county to catch or take oysters with a scoop, drag or dredge in any of the waters of said Lawful to catch oysters.

county not parcel of any creek, cove, river or inlet, upon obtaining license therefor as hereinafter directed.

Clerk required to issue license.

SEC. 95. The Clerk of the Circuit Court for said county, upon application of any citizen of said county, shall issue a license to such citizen, authorizing him to take or catch oysters with scoops, drags or dredges in the waters of said county, subject to the provisions of this law, for one year from the date of said license, for which said license the citizen applying shall pay to the said clerk the sum of ten dollars; provided that the citizen so applying shall have first satisfied the said clerk that he has obtained from the Comptroller of the State license to take or catch oysters in the waters of the Chesapeake Bay, as required by article seventy-one of the Code of Public General Laws; and provided also the said license shall not authorize the taking or catching of oysters between the first days of June and September in each year as forbidden by said article seventy-one of the Code.

Proviso.

Code of Public Local Laws, Article 19.

SECTION 96. The person so applying for a license shall first be required to make oath that he is a *bona fide* owner of the vessel to be licensed, that he has been a *bona fide* citizen of the State for one year immediately preceding said application and six months a resident of the county, and that the license is intended for his use only.

Laws of 1867, *Chapter* 129.

Penalty for violation.

SECTION 97. Any person taking oysters within the waters of said county with a scoop, drag or dredge without license, or who is not a citizen of said county, or otherwise, contrary to any law of this State, shall be subject to all the penalties provided by law against the illegal taking of oysters in this State.

Code of Public Local Laws, Article 19.

SECTION 98. In all cases where a vessel or individual shall be tried, either upon appeal or otherwise, for a violation of the provisions of the code

regulating the taking or catching oysters, and shall be acquitted or discharged by the Circuit Court or by a justice of the peace for Somerset county, the county commissioners shall pay the legal costs of defending the prosecution to such individual or the owner of such vessel.

SEC. 99. Any justice of the peace, upon the oath of any credible white witness, may issue a warrant to any sheriff, constable or other officer, civil or military, and to all persons licensed under the provisions of this law, to make all arrests and seizures necessary to carry the same into effect.

SEC. 100. The clerk of the Circuit Court shall be entitled to fifty cents each for every license granted under this law.

SEC. 101. He shall pay the money arising from the issuing of said licenses to the Treasurer of the school fund of said county, on or before the first Monday of June in each year, and his official bond shall be liable for the prompt payment thereof.

Laws of 1878, *Chapter* 373.

SECTION 1. *Be it enacted by the General Assembly of Maryland*, That it shall be unlawful to take or catch oysters with scoops, drags or dredges, or such like instruments, in the waters of the Wicomico River in Somerset county, on the east side of a straight line from the mouth of Rock Creek to Clay Island Light House, and any person violating this act shall be liable to be tried before any justice of the peace upon being arrested on warrant from any justice of the peace of said county, and upon conviction shall be fined not less than twenty-five dollars nor more than fifty dollars for every such offence, and shall also forfeit the boat or vessel used or employed in such violation of this act; and the said boat or vessel so forfeited and condemned shall be sold by the officer making the seizure or arrests, upon ten days' notice of such sale, for cash, together with the sails and furniture of said boat or vessel and the implements on board said boat used in such illegal taking of oysters; and one-half the proceeds of said sale shall be paid to the informer and party making the said seizure, and the balance shall be paid to the use of the public schools of said county; and any

Unlawful to use scoops, &c.

Penalty for violation.

Right of appeal.

party interested shall have the right of appeal to the Circuit Court for Somerset county from the judgment of any justice of the peace trying any cause arising for the violation of any of the provisions of this act.

TALBOT COUNTY.

See Dorchester County, Laws 1874, *Chapter* 437; *Laws of* 1876, *Chapter* 405; *Laws of* 1878, *Chapter* 359.

WICOMICO COUNTY.

See Dorchester County, Laws of 1868, *Chapter* 228.

Laws of 1872, *Chapter* 241.

Not lawful to take or catch oysters with scoops, &c.

SECTION 1. *Be it enacted by the General Assembly of Maryland*, That it shall not be lawful for any person or persons to employ any canoe, boat or vessel in catching or taking oysters with scoop, scrape, drag or dredge, or any similar instrument, within the waters of Wicomico county, nor shall any person or persons take or catch oysters for sale within the waters of said county otherwise than with tongs, as restricted and regulated by the provisions of the General Oyster Law in force in this State.

Protection of young oysters.

SEC. 2. *And be it enacted*, That for the protection of the young oysters in the waters of Wicomico county, it shall not be lawful for any person or persons to convey beyond the limits of said county any oysters from the fifteenth day of May until the first day of September in each and every year.

Persons violating forfeit property.

SEC. 3. *And be it enacted*, That any person or persons violating the provisions of either the first or second sections of this act, shall forfeit the canoe, boat or vessel in his or their possession, together with the tackle and apparel and all things on board at the time the offence may have been committed, and shall be fined in a sum not less than fifty dollars nor more than one hundred dollars for each and every offence, and shall stand committed to jail until such fine shall be fully paid and satisfied.

SEC. 4. *And be it enacted*, That on information

under oath of any violation of the provisions of this act to any justice of the peace in Wicomico county, he shall forthwith issue his warrant to the sheriff or any constable or military officer, requiring either of them to whom it may be directed to summon the *posse comitatus* if necessary, and proceed forthwith to arrest the party or parties alleged to have been engaged in the violation of this act, and to seize and take possession of any canoe or canoes, boat or boats, vessel or vessels, together with all their tackle and apparel and all things on board of the same belonging to said party or parties or in their possession at the time of the alleged offence or offences, and used by him or them in violating this act.

Information of violation.

Seize and take possession of property.

SEC. 5. *And be it enacted*, That the Sheriff, Constable or military officer who shall make the arrest, shall forthwith bring the offender or offenders before some justice of the peace of Wicomico county for a hearing, and the said justice of the peace shall either give the case an immediate hearing or at the instance of the party or parties charged with a violation of this act shall appoint some early day within the next five days thereafter to hear the case, the party or parties charged giving such good and sufficient bail as said justice shall require for his or their attendance; and on conviction of the offender or offenders the said justice shall decree a forfeiture of the canoe, boat or vessel, together with all the tackle and apparel and property found on board, and fine such person or persons in a sum of not less than fifty nor more than one hundred dollars in each and every case, and shall have power and authority to commit to the jail of said county such offender or offenders so convicted until such fine or fines so imposed shall be fully paid and satisfied.

Officer making the arrest bring before justice of the peace.

Decree a forfeiture.

SEC. 6. *And be it enacted*, That the justice of the peace before whom any such offender or offenders shall be tried and convicted, be and he is hereby authorized to order the officer making the arrest to sell the property so seized, on five days' notice, to the highest bidder, subject to an appeal in all cases to the Circuit Court of Wicomico county, and after the payment of the expenses attending the arrest and prosecution in any such case, the officer making the

On conviction property to be sold.

arrest shall retain one-fourth of the balance himself, distribute one-fourth among the parties assisting in making such arrest and seizure, and pay over the remaining one-half to the Board of School Commissioners of Wicomico county for the use of the public schools of said county.

Duty of the commander of the Oyster Police Force.

SEC. 7. *Be it enacted*, That upon information given under oath of any violation of the provisions of this act to the commander of the "Oyster Police Force" of this State, it shall be the duty of said commander to arrest the offender or offenders, to seize and take possession of any canoe, boat or vessel, together with all their tackle and apparel and property found on board, and deliver them over to the authorities of said county to be dealt with according to the provisions of this act; and the said commander is hereby authorized to follow such alleged offender or offenders and make such arrest and seizure in any part of this State as well as within the limits of said county.

WORCESTER COUNTY.

Laws of 1868, *Chapter* 343.

Disturb terrapins.

SEC. 2. *And be it enacted*, That if any person shall disturb terrapins or their eggs within the limits of Worcester county, between the first day of May and the fifteenth day of October, he shall forfeit and pay to the State not more than fifty dollars nor less than five dollars, to be recovered on information before some justice of the peace in said county, one-half of which penalty shall be paid to the informer and the other to the State, the same to be recovered in the same manner in which small debts are recovered before justices of the peace. And in all such cases an appeal shall lie to the Circuit Court of said county, subject to the same laws and rules that govern in similar cases.

Penalty.

SEC. 3. *And be it enacted*, That if any person shall take oysters for the purpose of converting them into lime, upon conviction in the Circuit Court for Worcester county, he shall forfeit and pay to the State of Maryland the sum of five hundred dollars, and the costs and charges accruing in the prosecution of the offender.

SEC. 4. *And be it enacted*, That the offences named or contemplated by this Act may be heard by any justices of the peace of this State before whom the offending party or parties may be brought, or any justice of the peace who, upon information, shall issue a warrant for the apprehension of any offender; the said justice, upon hearing proof, may either discharge the accused or require him to enter into recognizance with sureties in double the amount of the penalty for any violation of the provisions of this act, to appear at the then session or at the next term of the said court, to answer for the offence, and to satisfy the judgment which may be rendered against him therefor, or in default thereof to be committed to the county jail until such recognizance be given. Issue warrant.

SEC. 5. *And be it enacted*, That the officer executing such warrant shall take possession of and safely keep any vessel, boat, skiff, craft or other contrivance, with her tackle and appurtenances, which to the offender may belong or is being used, or to be used, or having been used in the commission of the offence for which he is prosecuted, and shall hold the same until the recognizance required be given, and the penalties, fees and fines be paid, or until the defendant be acquitted. Safely keep.

SEC. 6. *And be it enacted*, That if judgment be given against the defendant, it shall be a part of the judgment of the court, that if the penalties and costs be not forthwith paid, all the property so seized shall be sold and the proceeds accounted for as if it were the property of the defendant seized under execution for the satisfaction of the judgment. Judgment.

SEC. 7. *And be it enacted*, That for the seizure and safe keeping of any vessel or boat, with the equipments thereof, under the provisions of this act, the officer effecting the same shall receive a fee of twenty dollars, to be taxed in the cost, and the offender to be committed to the county jail until all penalties, costs, charges and fees are paid and the judgment against him fully satisfied. Fees.

SEC. 8. *And be it enacted*, That the informer, if there be one, shall be entitled to a moiety of any fine or forfeiture imposed by this act. Moiety.

SEC. 9. *And be it enacted*, That where a preceding is initiated for any violation of this act or any section thereof, on affidavit of such violation, a justice of the peace may issue his warrant for the apprehension of the offender, and it shall not be necessary therein to name the offender, the vessel or boat in his employment, and when the penalty is incurred by reason of the defendant being a non-resident the burthen of proof as to his residence shall be upon him.

Affidavit.

SEC. 10. *And be it enacted*, That if any person shall take, steal or sell planted oysters of another, knowing them to be such, from any of the waters in this act mentioned, he shall, upon conviction in said court, be fined not less than fifty nor more than one hundred dollars, and may, at the discretion of the court, be confined in jail not less than one nor more than six months.

Fine.

Section 1, *Chapter* 131 *of the Laws of* 1872 *is repealed and re-enacted by Section* 1 *A of Chapter* 77 *Laws of* 1874. *Chapter* 77 *of Laws of* 1874 *is repealed by Chapter* 277 *Laws of* 1876, *and re-enacted with amendments. Section* 6, *Chapter* 277 *Laws of* 1876 *is repealed by Chapter* 64 *Laws of* 1878, *and re-enacted with amendments.*

Laws of 1872, *Chapter* 131.

SECTION 2. *Be it enacted*, That it shall not be lawful for any person or persons other than citizens or actual residents of Maryland to haul or fish with any seine or seines of any description, rake or catch oysters, clams or terrapins, or plant oysters in the waters of Synepuxent Bay or any of the tributaries thereof, included in the boundaries of Worcester county.

Not lawful

SEC. 3. *And be it enacted*, That it shall be lawful for all citizens and residents of the State of Maryland to haul or fish with any seine or seines of any description in any of the aforesaid waters of Worcester county, *provided* that the meshes of all seines exceeding one hundred fathoms in length shall not be less than one and a half inches square, which is hereby expressly forbidden, and the use of which is hereby made and declared unlawful.

Fish with seines.

Proviso.

SEC. 4. *And be it enacted*, That it shall be and is hereby made unlawful for any person or persons to stop up the mouth of any river, creek or cove, by means of a seine or gill net, so as to prevent fish from passing in or out of said river, creek or cove. Unlawful.

SEC. 5. *And be it enacted*, That any person who shall violate any of the provisions of the preceding sections shall be deemed guilty of a misdemeanor, and upon conviction thereof before a justice of the peace, or upon indictment and conviction in the Circuit Court for Worcester county, shall be fined not less than twenty-five nor more than one hundred dollars, one-half of said fine to be paid to the informer and the residue to the school fund of the county; and in all cases of conviction of the party arrested, or sale of a boat, furniture and implements under this act, the officer making such arrest or seizure shall be entitled to a fee of twenty dollars, to be collected from the party convicted or from the proceeds of sale of said boat, tackle and implements in addition to all other costs; *provided* that this act shall not restrict or prevent traders or other persons from purchasing from or selling to non-residents the shell-fish in this act mentioned. Penalty for violating. Fine. Officer's fee. Proviso.

SEC. 6. *And be it enacted*, That if any citizen of Maryland shall be concerned or interested with any person not resident within this State in the taking, catching or planting of oysters in the waters of Synepuxent Bay or in any of the tributaries thereof included in the boundaries of Worcester county, or shall knowingly permit any person not a citizen and actual resident within this State to take, catch or plant oysters in his name, he shall be liable to the penalties and forfeitures imposed for the violation of the preceding sections of this act, and shall be proceeded against in the same manner; *provided* that nothing herein shall be construed to prevent the employment of non-residents as day laborers for the above purposes. Citizens of the State not to allow their names to be used fraudulently. Proviso.

SEC. 7. *And be it enacted*, That upon information given upon oath to any justice of the peace of Worcester county of any violations of any of the provisions of this article, the said justice of the peace shall issue his warrant for the arrest of the offender or offenders and the seizure of the canoe, boat or Information of violation.

Seizure.

vessel, together with the tackle and furniture on board, which warrant shall be directed to the sheriff or any constable of Worcester county.

Duty of sheriff.

SEC. 8. *And be it enacted*, That it shall be the duty of the sheriff or any constable of Worcester county, with or without warrant, to arrest any person or persons and to seize and take into custody any canoe, boat or vessel whenever and wherever such person or persons, canoe, boat or vessel shall be found violating or being used in violating any of the provisions of this article, and bring the offender or offenders before some justice of the peace or judge of the Circuit Court of said county.

Condemned property.

To be sold.

SEC. 9. *And be it enacted*, That all boats, vessels or other property condemned under the provisions of this article shall be sold by the sheriff or some constable of Worcester county, at public sale, after giving twenty days' notice of the time and place of such sale by advertisements posted in at least two public places in the vicinity of said sale, to the highest bidder for cash, and the boat, tackle and implements used by the party violating any of the provisions of this act shall be seized and taken in possession by the said constable or Sheriff, and in default of payment of the fine and costs aforesaid shall be sold at public sale as hereinafter provided, and as much of the proceeds of said sale as may be necessary applied to the payment of all fines and costs and other expenses incurred under this act.

Judgment.

May appeal from.

SEC. 10. *And be it enacted*, That any party or parties against whom any justice of the peace may render a judgment under this article, either to pay a fine or of condemnation of property, may at any time, within ten days from the rendition of such judgment, appeal from such judgment to the Circuit Court of Worcester county, but no execution or sale shall be stayed unless the party appealing shall give bond with security to the State of Maryland in double the value of the property condemned or of the fine imposed, as the case may be, said security or securities to be resident or residents of Worcester county, and who shall swear or affirm that he or they are worth double the amount of the property condemned, and becomes security, for the same with condition to prosecute such appeal with effect and to

pay the value of the property condemned and fine imposed and all costs attending such proceedings in case such judgment shall be confirmed.

Persons engaged in violating shall flee.

SEC. 11. *And be it enacted*, That if any person or persons on board any canoe, boat or vessel engaged in violating any of the provisions of this article shall abandon the said canoe, boat or vessel, and flee so as to escape arrest, the officer endeavoring to make such arrest shall seize such canoe, boat or vessel, and give information of such seizure to some justice of the peace or judge of the Circuit Court for Worcester county, and it shall be the duty of the said justice of the peace or judge to docket a case in the name of the State against the said canoe, boat or vessel, and to proceed without delay with the trial of the same, and if there is sufficient proof that said canoe, boat or vessel has been used or employed in violating any of the provisions of this article, the said justice of the peace or judge shall either render a judgment of condemnation against the said canoe, boat or vessel, her tackle and furniture on board at the time of, or fine the said canoe, boat or vessel not less than twenty-five dollars, one-half of said fine to be paid to the informer and the residue to the Treasurer of the School Board of Worcester county for the use of the school fund of said county.

Docket case.

Judgment of condemnation or fine.

Disposition of fines.

SEC. 12. *And be it enacted*, That the several justices of the peace and clerk of the Circuit Court for Worcester county be and they are hereby authorized and required to pay to the Treasurer of the School Board of said county, every three months, all the money or moneys they may have in hand at such times arising from fines, penalties or forfeitures imposed under this act.

Shells not to be removed.

SEC. 13. *And be it enacted*, That no person shall, under any pretext whatever, remove or take away any shells from any of the rocks or flats whereon oysters grow within the limits of Worcester county, and any person violating this section shall be liable to a fine of twenty-five dollars to be recovered as other fines or by judgment of any of the justices of the peace of said county, one-half to be paid to the informer and the residue to the Treasurer of the School Board of Worcester county, for the benefit of the school fund of said county.

Oysters in the shell disposed of

SEC. 14. *And be it enacted*, That all oysters in the shell disposed of in the waters of Worcester county shall be measured in a sealed measure of any capacity from half a bushel to two bushels that may be agreed upon between seller and buyer, and any person offending against the provisions of this section shall be subject to a fine of twenty-five dollars for each and every offence, to be recovered before any justice of the peace of Worcester county, one-half to the informer and the other half to the Treasurer of School Board of Worcester county, for the benefit of the school fund of said county.

To be measured.

SEC. 15. *And be it enacted*, That it shall be the duty of the purchaser or seller to have said measure or measures duly inspected and sealed by the standard keeper under a forfeit of twenty-five dollars for each and every offence, to be recovered before any justice of the peace of Worcester county, one-half to the informer and the other half to the Treasurer of School Board of Worcester county, for the benefit of the school fund of said county.

Repealed.

SEC. 16. *And be it enacted*, That all acts or parts of acts inconsistent with this act be and the same are hereby repealed.

Laws of 1876, *Chapter* 277.

Repealed and conditioned.

SECTION 1. *Be it enacted by the General Assembly of Maryland*, That chapter seventy-seven (77) of the acts passed January session, eighteen hundred and seventy-four (1874), for the protection of oysters in Sinepuxent Bay and its tributaries, is hereby repealed, but all violations of said act may be prosecuted and punished as fully as if said act had not been repealed.

Issue license.

SEC. 2. *And be it enacted*, That the clerk of the Circuit Court for Worcester county may issue to any citizen of said county a license to take or catch oysters with rakes or tongs from the waters of Sinepuxent Bay and its tributaries until the first day of May next after the issuing of said license; provided the applicant for said license shall satisfy said clerk, by his own oath or other sufficient proof, that he is a citizen of said county, and shall pay to said clerk the sum of one dollar, to be paid by said clerk to the County Commissioners of Worcester county, to be

Proviso.

expended in the procuring of seed oysters to be planted in said bay as the commissioners aforesaid may direct, but no person licensed as above, nor any other person, shall take or remove any oysters from the waters of said bay or its tributaries on any Sunday or in the night at any season, nor during the day from the first day of May to the first day of October, or any shells from the natural rocks at any time; provided that nothing herein shall be construed to forbid any person from taking or catching his or her own planted oysters at any time and with any kind of instrument; and any person violating any of the provisions of this section shall be guilty of a misdemeanor, and upon indictment and conviction therefor shall be fined not less than ten nor more than fifty dollars for each offence, with costs.

Proviso.

Penalty.

SEC. 3. *And be it enacted*, That no person shall catch, take or remove any shells or oysters from the natural beds in the waters of Sinepuxent Bay or its tributaries with scrapes, scoops, dredges or drags, or with any instrument in the working of which any other than hand power is used, and any person violating any of the provisions of this section shall, upon indictment and conviction therefor, be fined not less than fifty nor more than three hundred dollars for each offence, with cost.

Shall not catch.

Penalty.

SEC. 4. *And be it enacted*, That it shall be lawful for any citizen of Worcester county to plant, or for any resident to lay down, oysters on not exceeding five acres in any one place in any of the waters except upon the natural rocks of the said bay or its tributaries, and that no person, except the owner or his employee, shall work upon or among said planted or laid down oysters; provided that portion of the said waters so planted in be kept plainly marked with bushes, stakes or buoys, and any person maliciously removing said bushes, stakes or buoys shall be liable to the penalties of this section; and provided that nothing in this section shall effect the rights of owners of land to the exclusive use of any creek, cove or inlet, within their said lands, not exceeding one hundred yards in width at its mouth, and any person violating the provisions of this section shall be liable to be sued as for damage to any other property, and upon indictment and conviction

Be lawful.

Proviso.

Proviso.

Penalty.

for any such violation shall also be fined not less than ten dollars nor more than one hundred dollars for each offence, with costs, and in any prosecution for violating any of the provisions of this section it shall not be necessary to prove that the offender was taking up oysters, but only that he was at work in the waters within the bushes, stakes or buoys aforesaid.

Actual residents.

SEC. 5. *And be it enacted*, That no person other than actual residents of the State of Maryland shall catch clams or terrapins, or haul for or catch fish with any seine of any description in the waters of Sinepuxent Bay or its tributaries within the limits of Worcester county, and all persons violating any of the provisions of this section, upon indictment and conviction thereof, shall forfeit the boats and all seines and other instruments used in said violation, be fined not less than ten dollars nor more than fifty dollars, for each offence with costs, and be imprisoned until same are paid, but said imprisonment shall in no case continue more than thirty days.

Penalty.

Fines—to whom paid

SEC. 7. *And be it enacted*, That the net proceeds of all sales of property forfeited and fines imposed under this act shall be paid to the Treasury of the Board of County School Commissioners of Worcester county, and used as a part of the school fund of said county.

Laws of 1878, *Chapter* 64, *repeals Section* 6 *of Chapter* 277 *of Laws of* 1876 *and re-enacts the same, as follows:*

Laws of 1878, *Chapter* 64.

Not lawful

6. It shall not be lawful for any person or persons to haul or fish in any of the waters of Synepuxent Bay or its tributaries comprised within the limits of "Worcester county," with any seine containing meshes less than one and a half inches square, unless said seine shall be less than one hundred fathoms in length.

Seine.

SUB-SEC. 6. Any person who shall violate any of the provisions of the preceding section shall be deemed guilty of a misdemeanor, and upon conviction thereof before a justice of the peace, or upon indictment and conviction in the Circuit Court for

Worcester county, shall be fined not less than twenty-five dollars nor more than one hundred dollars, one-half of said fine to be paid to the informer and the residue to the school fund of the county. Penalty.

CASES RELATING TO THE ABOVE SUBJECT MATTER.

Construction of Statutes 1833, Chapter 1833; Chapter 254, 1837; Chapter 310 State *vs.* Mister, 5 Maryland, 11, Constitutionality of Law inflicting penalty of forfeiture.

Smith *vs.* State of Maryland, 18 Howard, 71, Sections 15, 16, 17, 18, Article 71, Code of Public General laws, are not in violation of the Constitution of the State.

Phipps *et al.*, *vs.* State, 22 Maryland, 389.

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